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ROENTGEN DIAGNOSIS OF CHRONIC ARTHRITIS[1]

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IN spite of the tremendous amount of research which has been done on the subject, chronic arthritis still remains one of the great unsolved problems confronting the medical profession to-day. The lack of exact knowledge of the etiology of chronic arthritis has been a great handicap in its classification and management. The past few years, however, have witnessed a renewed interest in the subject and a closer co-operation of those interested. The formation of the new society, in this country, for the control of rheumatism is an indication of the efforts in this direction.

The classification has been gradually simplified and clarified until at the present time it is almost universally recognized that there are two great groups of arthritis. The terminology of these two groups varies widely in different parts of the world and to a lesser degree in individual countries. The terms "atrophic," "rheumatoid," and "proliferative" refer to the same type of arthritis; similarly, the terms "hypertrophic," "osteoarthritis," and "degenerative" refer to the same arthritic group. Because the terms "atrophic" and "hypertrophic" are more generally used in this country and, also, because the names are indicative of the principal changes seen on the roentgenogram, we prefer their use and shall use them in this communication.

[1] Read before the Radiological Society of North America, at the Twentieth Annual Meeting, at Memphis, Tenn., Dec. 3–7, 1934.

The roentgen-ray diagnosis depends on both direct and indirect findings. Direct findings are those structural changes which can be definitely seen and measured on the roentgenogram, such as bone changes. The pathologic bone changes may be due to destruction, bone proliferation, or bone displacement. The physiologic bone changes are usually due to disuse of the part and are manifested by absorption of the lime salts, or osteoporosis. There may also be increased deposition of lime salts, or eburnation, in certain circumstances which will be spoken of later. Direct findings must also include swelling of the soft tissues about the joint; indirect findings are those changes which are not directly visible on the roentgenogram but which produce alterations in the visible structures so that certain pathologic processes may be inferred.

In this communication we shall discuss the changes in chronic arthritis of the peripheral joints only, and shall not discuss those of the spine, as we have recently covered them in another communication before this Society (2).

Atrophic Arthritis.—Atrophic arthritis is a gradually developing polyarticular disease which may involve any joint in the body, the incidence being highest from the third to the sixth decades of life. It occurs frequently in individuals who are thin, visceroptotic, and of a neurotic type. The joints of the hands are often the seat of the

first symptoms. There is a gradual development of pain, stiffness, and swelling of the joints which soon become fusiform in shape: the development of pain produces disuse of the joints which results in muscular and bone atrophy. Unless the process is stopped at this point various degrees of deformity and ankylosis will result.

The swelling around the joint is due to fluid in the joint together with swelling of the synovial membrane and capsule. Practically all writers agree that the disease begins in the synovial membrane and then spreads to the other joint structures. The scope of this paper does not permit any detailed clinical or pathologic description, but

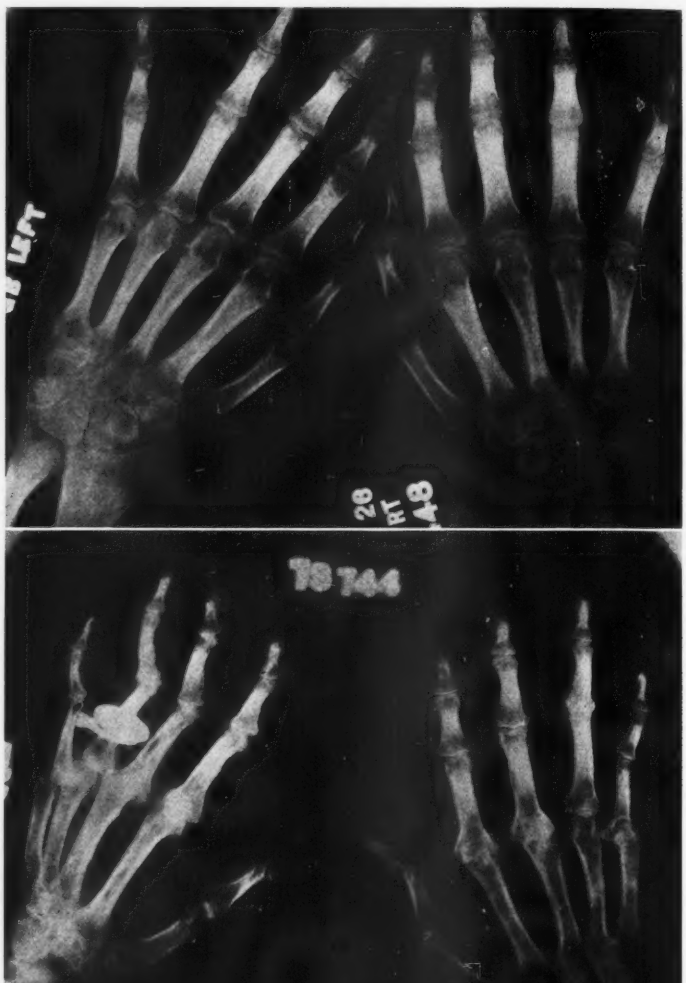

Fig. 1 (*above*). Early stages of atrophic arthritis. Osteoporosis with soft tissue swelling. Very little cartilage destruction. No bone destruction.
Fig. 2 (*below*). More advanced stage of atrophic arthritis with cartilage and bone destruction and beginning luxation of fingers.

a few of the above facts are necessary to a proper understanding of the development of the roentgen-ray changes which we shall attempt to trace.

Fig. 3. End stage of atrophic arthritis with marked deformity and ankylosis.

In describing the roentgen changes we shall attempt to show that they appear coincidentally with the progress of the disease, and in general are the result of certain well-known laws of cause and effect. The earliest change is swelling of the synovial membrane and this, being an inflammatory change, is followed by a collection of fluid. These changes are recognizable roentgenographically by an increase in the soft tissue shadow outline and also by changes in the normal position of the bones: this is especially well shown in the patellar displacement. There may also be obliteration of the normally clear area in the post-patellar space and in similar spaces around other joints. These changes are not pathognomonic of atrophic arthritis, however, as the same changes may be seen in cases of acute polyarticular rheumatism, or after injury to the soft tissues of the joint. No bone or cartilage changes are seen at this time.

As the process continues to develop, the next structure affected will be the articular cartilage. As cartilage is not visible on the roentgenogram, indirect evidence of this destruction will be shown by a narrowing of the normal joint space. This may be slight or, in severe cases, there may be complete destruction of the cartilage so that the articulating portions of the bones may be approximated: in the latter cases there are usually some areas of bone erosion. At this time the disease has usually been present long enough so that secondary physiologic changes are present. Owing to the disability, we find evidence of osteoporosis of the affected members and atrophy of the soft tissues above and below the joints. Swelling of the joint area will usually be present, which produces the well-known fusiform shape seen in long standing inflammatory joint affections. In some cases, there are punched-out areas of bone destruction along the articular surfaces such as are seen in gout, and in other cases there may be complete erosion of the articular surfaces. Also, there may be partial or complete dislocation due to muscular contraction.

When the progress of the disease is brought under control, the opportunity for

Fig. 4. Early stage of hypertrophic arthritis with slight bone production. No narrowing of joint space.

Fig. 5. Later stage of hypertrophic arthritis with more extensive bone production and beginning cartilage absorption.

reparative processes is at hand. The soft tissue swelling decreases; the articular cartilage which has practically no recuperative powers, owing to a lack of circulation, shows very little or no regeneration. In cases in which extensive destruction has taken place, ankylosis is usually the end result. In some cases there will be fibrous ankylosis, and in others in which the destruction has extended into the bone on both sides of the joint there will be an actual bony ankylosis.

The above description applies only to cases of sufficient severity to carry them through the entire course of the disease. All degrees of involvement are found, from those which show soft tissue changes only and return to essentially normal joints, to those which end in complete disability of the patient.

Hypertrophic Arthritis.—Hypertrophic arthritis is a condition common in elderly persons but which may be present in younger ones whose joints have been subjected to abnormal conditions, such as trauma. We believe that advancing age with its attendant factors of arteriosclerosis and fibrillation of the cartilage, together with long continued use of the joint, are the chief etiologic factors in this disease.

It has recently been shown by Keefer and Myers (7) that a high percentage of persons past middle age coming to autopsy show anatomic alterations similar to those

of hypertrophic arthritis. They believe these gross changes come about as a result of aging of the cartilage and from trauma. Trauma in this sense must include physiologic trauma from overuse of the joint and from faulty mechanics, as well as external trauma.

In the early stages, fibrillation and localized areas of destruction of the articular cartilage occur. This is shown roentgenographically by areas of roughening due to bone production at these sites. There is also the very commonly observed spur formation or lipping at the articular margins, especially at the attachments of the ligaments.

As the condition progresses, there is increasing cartilage disintegration which is shown by narrowing of the joint space and approximation of the bony surfaces. Inasmuch as these joints are not acutely painful, there is very little disability and, therefore, osteoporosis is not seen. There may even be some increased density of the bones, especially along the articular surfaces which may become highly polished and eburnated from the constant friction of the opposing bones. Small loose bodies called joint mice may be present in or about the joint, causing mechanical locking of the joint and sometimes swelling and increased fluid. These joint mice are composed of cartilage or bone or a combination of both and are usually derived from detached pieces of cartilage or bony exostoses. The marginal spur formations extend outward and toward the spur formation on the opposing bone and, while they may progress to a point where they are in close approximation, they rarely unite to produce ankylosis. In cases in which ankylosis occurs, it is usually due to mechanical interlocking or to some outside influence, such as severe trauma followed by bone production.

A rather mild and early form of hypertrophic arthritis is the occurrence of lipping around the bases of the terminal phalanges of the fingers. These are the so-called Heberden's nodes, and are very common in females past middle life who have worked hard with their hands. There is widening of the articular surfaces with some increased density and considerable marginal lipping: there may or may not be narrowing of the joint space.

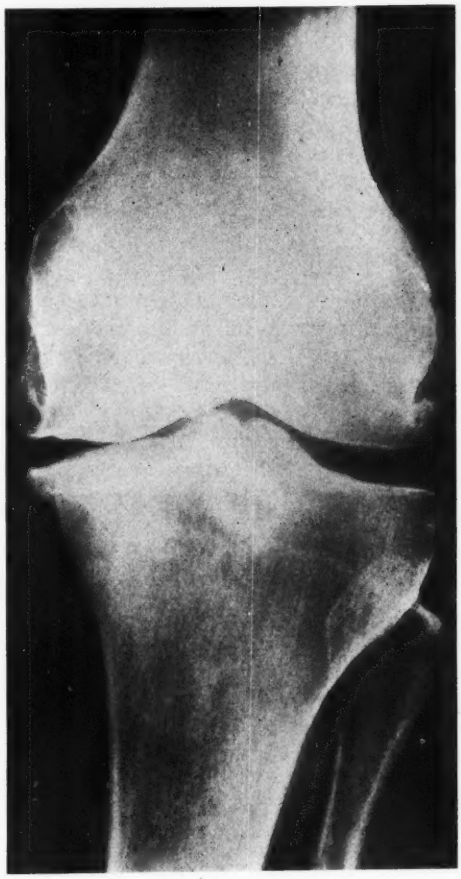

Fig. 6. Anteroposterior view of knee shown in Figure 5.

Cases of monarticular hypertrophic arthritis are sometimes seen and in many instances its presence may be ascribed to constantly repeated traumas. Probably the most typical example of this is seen in the hip joint. For many years this was described as a separate entity and was given the name "morbus coxæ senilis": it is now recognized to be the same as hypertrophic arthritis, affecting other joints. Some cases appear to follow slipping of the upper femoral epiphysis in childhood;

others may follow mechanical deformities which produce long continued strain. Roentgenographically, we see the characteristic spur formation which may be of extreme degree. There may be considerable deformity with absorptive changes in the head of the femur and sometimes a displacement of its normal position.

DISCUSSION

A summary of the main points set forth in regard to these two great types of arthritis reveals the fact that while in the main they are distinct entities yet they have certain points of similarity and frequently are seen as mixed types. They are also in some instances indistinguishable from other types of arthritis at certain stages of their course.

Atrophic arthritis is likely to be more rapid in its development, more disabling, and more painful than is hypertrophic arthritis. Osteoporosis is one of the prominent roentgen signs of atrophic arthritis; in hypertrophic arthritis, eburnation or increased density is usually present. The density of the bones is even greater than that usually seen in normal bones of this age period, as some grade of osteoporosis is usually seen after middle age. Both show evidence of cartilage destruction with narrowing of the joint space, but this process is more pronounced and occurs earlier in atrophic arthritis. Bone proliferation in atrophic arthritis is usually followed by ankylosis of the joint, while in the hypertrophic form marginal lipping is one of the characteristic early roentgen signs and may not indicate the presence of any symptoms at that time. Ankylosis is a very infrequent occurrence in hypertrophic arthritis, although extensive bone production may be present about the joints.

Mixed types of arthritis are rather frequently seen and it is often difficult to say which type antedated the other. It is also difficult in some cases to distinguish between the two types from pathologic specimens, either by gross or microscopic examination.

Some of the pathologic and roentgenologic changes which are seen at certain stages of chronic arthritis are quite similar to those seen in other types of arthritis. Tuberculosis and atrophic arthritis have some points of similarity which at times may cause confusion. Osteoporosis is a definite characteristic of each at certain stages, cartilage destruction is common to both, focal areas of bone erosion may occur in each, and pannus formation may be present over the cartilage. Osteoporosis in tuberculous arthritis is likely to be quite intense so that the articular surfaces are seen with difficulty and show a blurred appearance. This degree of osteoporosis is greater than is usually seen associated with atrophic arthritis and suggests that there is an osteolytic agent present. Cartilage destruction may be present in both types, but in tuberculosis it often appears after bone destruction has already been seen and may be a late development in the course of the disease. In atrophic arthritis it usually antedates bone destruction and is an early occurrence. In tuberculosis, various types of bone destruction may be seen but it commonly begins at the edge of the articular surface, along which it gradually extends with loosening of the overlying cartilage. Marginal erosion is also seen in atrophic arthritis and there also may be punched out areas of destruction along the articular surfaces.

Hemophiliac arthritis may present roentgen signs that are similar to those of chronic arthritis. In mild cases there is effusion into the joint space, thickening of the joint capsule, and lipping similar to that seen in hypertrophic arthritis. In a more advanced group we find cartilaginous destruction: this may be local or may involve the entire cartilaginous surface of the joint. There is also bone destruction of two types: (1) punched-out areas in the epiphysis, with an intact articular surface due to hemorrhage into the epiphysis; (2) generalized destruction of the articular surfaces. In some cases the blood clot in the synovial cavity becomes organized and shows calcification; when this occurs, it is pathognomonic of hemophiliac arthritis.

Gout is also a condition in which the roentgen findings may simulate those of chronic arthritis. The joints of the hands and feet show the most characteristic findings, but in many of the other joints the findings are not diagnostic. The typical roentgen changes are well defined rounded areas of destruction in the ends of the bones at the margins of the articular surfaces. There also may be destruction of the articular cartilage and erosion of the articular surfaces of the bones. There is usually not much osteoporosis present. In some of the milder cases there is lipping around the articular surfaces similar to that seen in hypertrophic arthritis. When the larger joints are involved, the changes often suggest hypertrophic arthritis but in these cases roentgenograms of the hands and feet may show the characteristic punched-out areas of bone destruction and afford a clue to the etiology of the disease.

SUMMARY

1. Chronic arthritis consists of the following two types: (1) atrophic, and (2) hypertrophic.

2. A brief résumé is given of the basic roentgen changes which may be present in chronic arthritis.

3. Atrophic arthritis is described briefly from the clinical side, and more fully from the standpoint of the roentgen-ray changes.

4. The etiology of hypertrophic arthritis is referred to. Trauma seems to be a definite factor here. The roentgen changes throughout the course of the disease are described.

5. The differential diagnosis between chronic arthritis, tuberculous arthritis, hemophiliac arthritis, and gout, is briefly discussed.

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SURGERY AS AN ADJUNCT TO THE TREATMENT OF ARTHRITIS[1]

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THE application of surgical principles is often as essential in the treatment of arthritis as the determination and eradication of the causative agent. If the individual affected with arthritis is permitted to become helpless, or, if he is already in this state and is not restored to activity, his resistance and morale will become markedly depressed. The removal of all foci of infection, while absolutely essential, is often disappointing, as the joints may be an additional source of infection.

In 5,132 cases of arthritis taken from the records of our clinic, surgical treatment has been employed in approximately 900, which demonstrates how frequently such measures are required. With the exception of pyogenic infections, operative surgery is rarely indicated when the process is very active or acute. The response to surgery is more favorable in the residual stage after the process has subsided; however, it is frequently resorted to in subacute cases in order to restore more activity to the individual.

The main mechanical objectives are the prevention and correction of deformity, and the restoration of function. These may be divided into conservative or non-operative, and operative cases, as follows:

Non-operative	1. Prevention of deformity 2. Correction of deformity 3. Restoration of function
Operative	1. Drainage in acute infections 2. Excision of pathologic tissue 3. Brisement forcé 4. Plastic procedure for elongation of extra-articular contraction 5. Reduction of dislocations 6. Removal of mechanical intra-articular obstruction 7. Fusion 8. Reconstruction 9. Arthroplasty 10. Sympathectomy 11. Two or more objectives combined

[1]Read before the Radiological Society of North America, at the Twentieth Annual Meeting, in Memphis, Tenn., Dec. 3–7, 1934.

NON-OPERATIVE METHODS

1. *Prevention of Deformity.*—When there is irritation in a joint from such cause as trauma, infection, or other agents, that joint will assume a position in which intra-articular pressure is the least and muscular relaxation is the greatest. This may be designated as the neutral position, an effort on the part of Nature to relieve pain and limit destruction from intra-articular pressure. Unfortunately such a position is one which, if permanent, will naturally impair future function; therefore, as long as there is any active irritation within a joint, it is obviously most important that an apparatus should be employed to maintain that position which will be most serviceable for future use. The neutral position is always one of more or less flexion. For example, an ankle joint is held in equinus or plantar flexion when there is intra-articular inflammation. This must be prevented by a splint which extends from the toes to just below the knee and holds the foot at a right-angle to the leg. The most serviceable position for future use is the position of choice in all joints. A knee which is flexed should be fixed in full extension, a wrist in extension, and an elbow at a little less than a right-angle.

2. *Correction of Deformity.*—Unfortunately measures for the prevention of deformity are not always instituted or efficiently carried out, with the result that malformation often occurs. This may so impair function as to render the individual totally disabled. In those cases observed before there are slight organic changes of the joint or peri-articular structures, correction may usually be accomplished by continuous traction. If the organic changes are of a moderate degree, special apparatus constructed to meet the mechanical requirements of each joint may be necessary in order to restore the joint

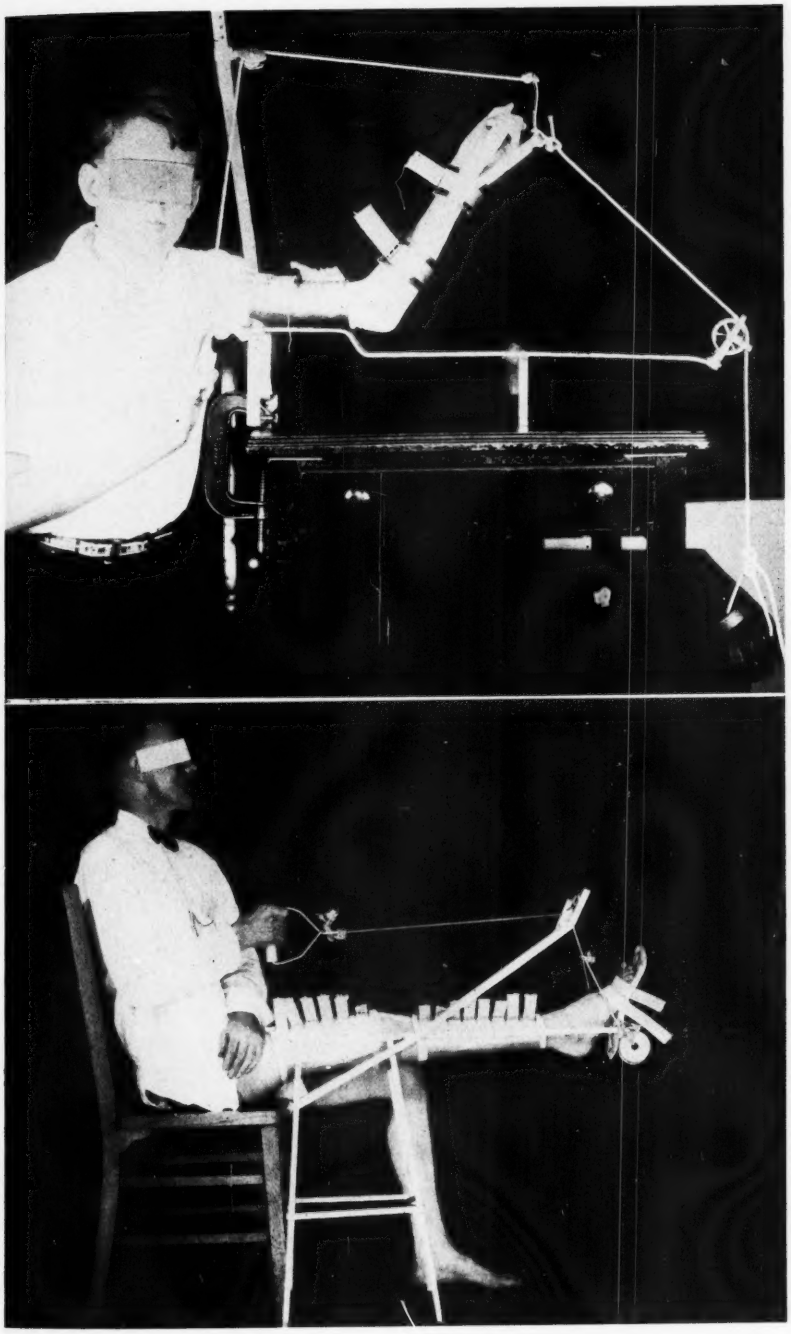


Fig. 1 (*above*). Apparatus to facilitate the gradual induction of motion in the elbow.
Fig. 2 (*below*). Knee exerciser to increase active and passive motion.

to a normal position. Those suitable for such treatment are the joints that cannot be placed in the anatomical position on the thigh, preventing the usual tendency of the tibia to subluxate until complete extension is secured. When the joint has been restored to the most serviceable position for future use, splints or braces are applied to maintain the position and to permit function as early as possible. Splints must be more or less continuously applied until the individual can completely extend the joint or joints in question by his own volition. This statement cannot be emphasized too strongly, not only when conservative measures are employed, but also after operative procedure.

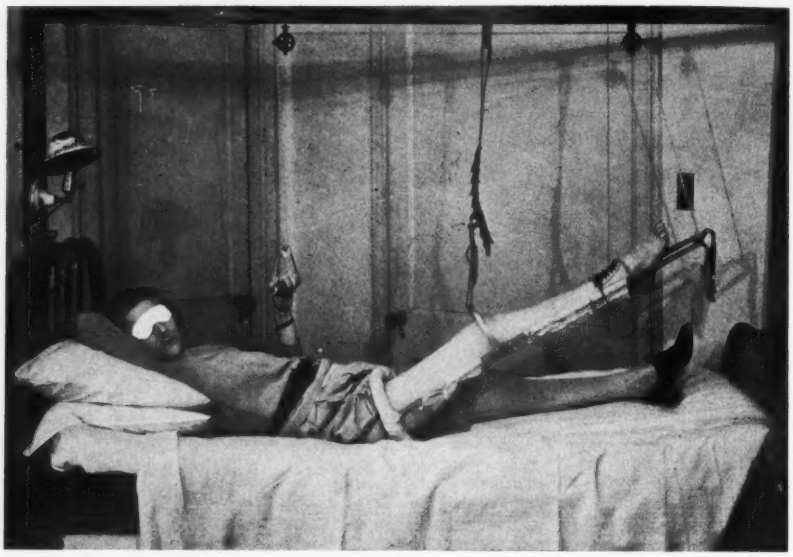


Fig. 3. Overhead frame with system of pulley and rope to develop motion in the knee in bed-ridden patients.

Fig. 4. Specimen removed from knee at synovectomy, showing hypertrophied synovial membrane and semilunar cartilage.

account of adhesions or contractures, but possess a few degrees of motion. For example, in the knee, plaster of Paris casts or steel braces with turn buckles and pressure pads are applied so as to make traction and gradually extend the leg on

3. *Restoration of Function.*—Active and passive movements are encouraged if local signs of inflammation are not instigated thereby. Rest is always indicated when any process is acute. Physiotherapy in various forms is often a valuable adjunct. Special apparatus is constructed to meet the requirements of each joint, designed to aid in active motion and increase passive motion. For example, in the elbow and the knee, apparatus is applied as demonstrated in Figures 1 and

2, which greatly facilitates the gradual induction of motion. Also, in Figure 3 is shown a system of overhead slings and pulleys with block and tackle which can be applied effectively at very little expense. These measures are beneficial not only when deformity has been prevented or corrected, as described above, but also after various operative procedures to be described below. If conservative or non-operative measures are applied in the early stage, operative treatment will rarely be indicated. Unfortunately, these procedures are seldom carried out and intra-articular and extra-articular changes that require radical surgery develop. Postural defects are of material importance and should be corrected in all cases, but so much has been written by Goldthwait, Swain, and others on this subject that detailed discussion is omitted.

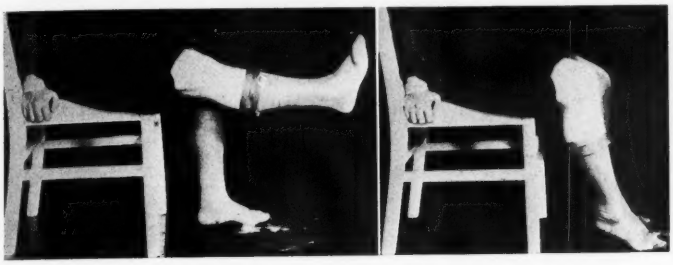


Fig. 5. Fig. 6.

Figs. 5 and 6. Post-operative result following synovectomy of knee.

OPERATIVE PROCEDURES

1. *Drainage in Acute Infections.*—Drainage in acute pyogenic infection of joints is rarely indicated unless the process is highly virulent, as indicated by symptoms of severe sepsis. When advisable, the incision should be made at that point which will give the most efficient drainage of the joint. In the knee, as a rule, two lateral incisions parallel with the patella are sufficient, but drainage of the posterior compartment, consisting of inner and outer incisions over the posterior aspect may be required. Drainage of the posterior compartment may rarely be necessary through the posterior capsule in the mid-line. After drainage of a knee, active motion every one or two hours, the so-called Wilhelm's method, may be of value in some instances. However, the method is more efficacious in gunshot wounds, for which it was devised. The hip may be drained more effectively by the posterior method, as described by Ober. Early drainage is more often required in the hip, as a large portion of the neck of the femur is within the joint capsule, and direct infection of the bone or osteomyelitis is imminent.

Fig. 7. Fig. 8.

Figs. 7 and 8. Post-operative result following bilateral posterior capsulotomy.

2. Excision of pathologic tissue is obviously of value in loose bodies, enlarged villi, benign tumors, exostoses, and induration or fibrosis of the synovia. Loose

Fig. 9.

Fig. 10.

Fig. 11.

Figs. 9 and 10. Flexion contracture of knee, pre-operative and post-operative. Fig. 11. Progressive polyarticular arthritis.

bodies are more frequently formed as a result of osteochondritis dissecans, synovial osteochondromas or osteochondromatosis, and osteo-arthritis or the hypertrophic type of arthritis. Enlarged villi rarely mechanically interfere enough with function to require removal. Benign tumors such as lipoma, fibroma, and angioma should be removed, regardless of mechanical symptoms, as soon as the diagnosis has been made. Exostoses or osteophytes as a result of osteo-arthritis apparently may impair mechanical function and cause symptoms, but their removal rarely gives the desired relief. The operative procedure for these conditions is a very simple measure in the superficial joints such as the elbow, knee, and ankle, but is somewhat more complicated in the hip. In loose bodies, enlarged villi, and benign tumors the results are excellent as a rule, as the etiologic factor is excised. In low grade infections, traumatic arthritis, osteo-arthritis and osteochondromatosis the synovial membrane may be indurated with enlarged villi, thickening of the capsule, and persistent fluid, distending the joint which may be resistant to every form of conservative treatment. In such a case much benefit may be secured by synovectomy, an operation which consists of excision of the synovial membrane. The operation is more frequently employed in the knee. A medial incision is made parallel with the quadriceps, patella, and patella tendon into the joint. The entire synovia is dissected from above downward with the semilunar cartilages and removed from the joint; the joint is then closed in routine manner and active and passive motion instituted on the tenth day. In monarticular affections, excel-

lent results are usually secured in a condition not amenable to any other form of treatment. Synovectomy also is employed frequently when the process is polyarticular. At times, foci of infection are removed in this manner and the general process arrested; however, the results are by no means as satisfactory as in monarticular affections. Synovectomy absolutely refutes the old adage that the "loss of joint fluid or oil induces ankylosis." In fact, not only is the fluid lost, but the means by which the fluid is formed. However, after the operation a new synovial membrane is reproduced by nature, which secretes normal joint fluid.

3. *Brisement forcé*, or the employment of excessive force under anesthesia, very rarely is indicated in the treatment of injuries and diseases of the joints. Severe and irreparable damage, as crushing of articular surfaces, gross fractures, tearing of the articular structures, severe traumatic fractures, and relighting of virulent infection, often occur. Function in a joint usually can be cultivated to better advantage gradually and not forced. If adhesions are so strong as to require excessive force, open operative measures are indicated.

4. Plastic procedures for the elongation of extra-articular contractures are indicated when there is no involvement of the joint, and fibrosis of these structures has progressed to such a degree that restoration to the most serviceable position cannot be secured by the conservative measures described above. Operative measures for this purpose have improved materially during the past twenty years. Formerly, blind tenotomies, fasciatomies, and osteotomies were employed in which the function of important structures was impaired by severance and filling in with dense scar of the space gained thereby. This often later contracted, with more or less recurrence of the deformity. We now employ well planned open operations in which the contractures can be elongated with conservation of normal tissue and reduction of healing by scar tissue to a minimum. These measures can be illustrated by certain operations. When there is extensive flexion contracture of the elbow, motion may be possible only from a right-angle to complete flexion. In order to secure extension, anterior capsulotomy is accomplished by a medial approach; the median nerve and vessels are isolated and retracted outward and forward, and the entire capsule is resected, which always consists of dense scar tissue. This often will permit complete extension. Otherwise, a lateral incision is made and the biceps and brachialis anticus are elongated by the Z-shaped plastic method. In flexion contracture of the knee by a similar procedure, the posterior capsule is severed, scar tissue resected, and if necessary, hamstring tendons elongated. If external rotation of the leg is present, the biceps is also elongated. This measure has almost completely replaced the supracondylar osteotomy, which caused deformity of more or less degree resembling a golf stick, and did not permit the return of the full range of motion. When the knee is fixed in complete extension by contraction of the anterior structures, elongation of the quadriceps muscles is secured which will

Fig. 12. Post-operative result following arthroplasty of both hips.

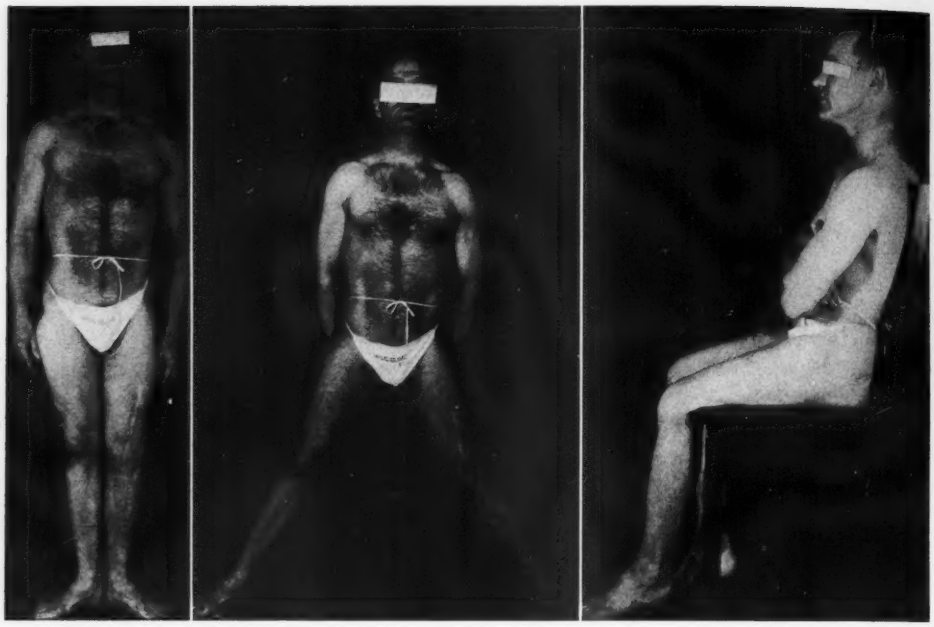


Fig. 13. Fig. 14. Fig. 15.

Figs. 13, 14, and 15. Same patient as shown in Figure 12, showing motion present after arthroplasty of both hips and of left knee.

permit full flexion. If the hip be extremely flexed in abduction or adduction, the operation described by the author as transference of the crest of the ilium may be employed. This consists of exposure of the hip by a long anterior incision. The gluteal muscles attached to the crest or dorsum of the ilium are severed at their attachment and the capsule of the hip is incised by a Z-plastic incision so as to conserve the Y-ligament: this will permit the limb to be extended. If the adductors are contracted, they may be severed at their insertion by a subcutaneous tenotomy: this will permit the hip to be placed in the desired position and the muscles to be reattached at a lower level. All structures are thus conserved, the normal nerve and blood supply having been in no manner impaired. The results are excellent and a functional range of motion is secured. In some instances there is a normal range of motion. When both hips or knees are involved, the individual is chair-ridden, but, after a series of operations as described above, can often be enabled to walk. The very act of walking is an important agent in improving the morale as well as the resistance of the individual to combat the causative agent.

5. Reduction of dislocations unless obtained very early can be accomplished only by an open operation, as the adhesions are much stronger than the bone, which is always atrophic. Unless observed within one or two weeks after dislocation, reduction is practically always followed by ankylosis. The articular cartilage of the entire articulation undergoes rapid fibrillation and aseptic necrosis, for the joint fluid which acts both to nourish and to lubricate is lost.

6. Removal of mechanical intra-articular obstruction, usually caused by scar tissue, rarely by bone, is at times indicated, but more often is employed in conjunction with other measures described above and below.

7. Fusion or arthrodesis is an operative procedure for the purpose of inducing osseous ankylosis, and usually is indicated

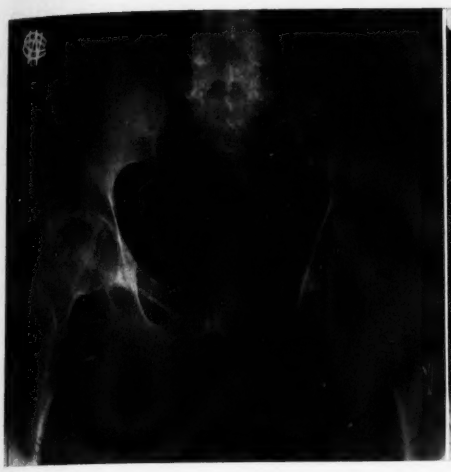


Fig. 16. Ankylosis of both hips due to progressive polyarticular arthritis.

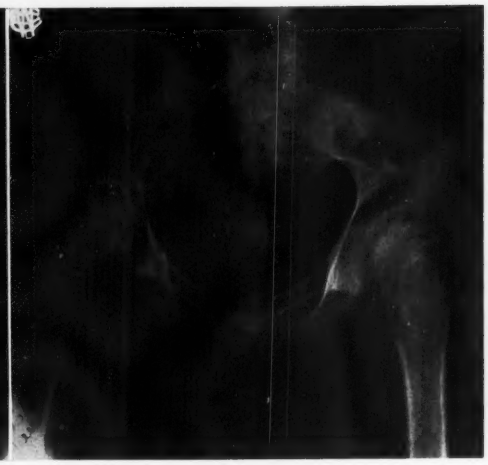


Fig. 17. Same patient as shown in Figure 16, after arthroplasty of both hips.

for the purpose of relieving pain in a joint in which the destructive changes are so advanced that restoration to a practical degree of painless function is impossible. The operation may be indicated in any joint but is employed more frequently in that of the hip. A wide exposure is made, with complete denudation of the head and acetabulum. In addition, the greater trochanter with muscle attachments is transferred across the joint and multiple flaps of cavernous bone are turned down from the ilium. The procedure is commonly used in monarticular affections, as in osteo-arthritis, or so-called coxa malum, and in the residual stage after any destructive process has caused an irregular or incongruous articulation. In progressive polyarthritis, rheumatoid arthritis, or atrophic type of "arthritis deformans," one hip joint may cause such extensive disability from destructive changes, with excessive pain, that the individual may be unable to walk. In such cases the evolutionary process may require years before there is a relief of pain from osseous ankylosis. Therefore, the author has employed fusion in some instances, with arrest of the local process. This has enabled the patient to return to a more normal life and is a valuable adjunct to any form of treatment.

8. Reconstruction operation is employed only on monarticular affections of the hip joint. The operation was devised for ununited fracture of the neck of the femur. It consists in the excision of the head, detachment of the trochanter, and the placing of the upper extremity of the femur into the acetabulum, after which the trochanter is attached to the femur at a lower level. A movable joint is thus secured but it is not comparable to the normal joint, as there may be more or less pain and disability. Fusion gives more certain relief but many decline to submit to an ankylosed hip.

9. Arthroplasty is the reconstruction of a joint by a surgical operation when there is complete ankylosis. The operation consists of remodeling the articular surfaces, after which some material is interposed for the purpose of inducing free motion and preventing recurrence. For this purpose a free transplant of fascia lata is employed most frequently. This procedure may be employed when there is multiple ankylosis but is indicated more frequently in monarticular ankylosis, as a result of acute pyogenic infection after the process has entirely subsided and has reached the residual stage. Distinction must be made between an arthroplasty

and excision or such measures as reconstruction. In arthroplasty there must be due regard to all of the component parts of the joint as muscles, ligaments, blood vessels, nerves, etc., if function is to be restored. Arthroplasty is not merely the removal of an area of bone for the purpose of inducing pseudo-arthrosis. At best, a joint reconstructed by arthroplasty does not approach the normal, but an excellent, durable, and efficient joint may be restored. Anatomic restoration is not always possible or feasible. In the knee and elbow, the construction of a simple hinge joint will be an excellent substitute. The reproduction of the normal spine and the intercondylar notch with condyles and tuberosities will not function as a normal knee, for there are no crucial ligaments. The circulation is not sufficient to sustain the anatomic contour, which becomes modified in time by aseptic necrosis and absorption. Therefore, in 1918, I began to reproduce a different type of joint which consisted of making one convex condyle of the femur, one shallow concave surface on the upper extremity of the tibia, and removal of as much of the posterior portion of the patella as was consistent with tensile strength. This restored a much simpler hinge joint, which gave practical function in a much higher percentage of cases than I had been able to attain by conforming strictly to anatomic contour. Arthroplasty is of particular value in the jaw, elbow, hip, and knee. These are the joints in which there is the greatest disability following ankylosis. In monarticular ankylosis a high percentage of restoration of function is secured. The results in multiple ankylosis and in those with progressive ankylosing arthritis are far from satisfactory, but, as the condition is so disabling and hopeless, any effort that offers the slightest chance of relief is worth a trial. In polyarticular ankylosis, there is much difficulty in securing the necessary after-treatment essential to the physiologic reconstruction of the new articulation because of the inability of the patient to co-operate in exercising the new joint. An analysis of the end-results has been previously published to which reference can be made.

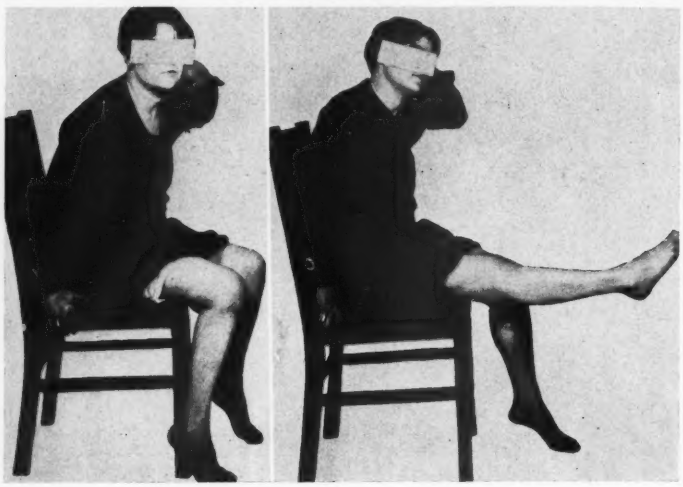


Fig. 23. Fig. 24.

Figs. 23 and 24. Motion present after arthroplasty of the knee.

Fig. 18. Ankylosis of hip following monarticular arthritis.

Fig. 19. Same patient as shown in Figure 18, after arthroplasty.

The type of articulation reconstructed has been clearly demonstrated by the examination of specimens from joints in which motion has been secured by arthroplasty. For example, in a knee one year after operation there was a definite joint cavity about one-half the size of a normal joint, with joint fluid. The surface was covered with a fibrous membrane closely resembling the fascia lata which had been interposed at operation. The microscope demonstrated, counting from within out, a layer of fibrous tissue, fibrocartilage, and cavernous bone. The fibrocartilage was invading the sub-articular, intra-osseous spaces. In those joints that were examined after two or more years, the fibrous layer was substituted by fibrocartilage, but in no instance did it resemble normal hyaline cartilage. The same type of joint that is secured after arthroplasty has been demonstrated after complete destruction of an articulation from any one of many causes, and must be regarded as Nature's substitute for a normal joint.

10. Cervical or lumbar sympathectomy, or the resection of the sympathetic ganglion, has been employed so as to produce vasomotion dilation, with elevation of the local temperature. This procedure is more in the province of neurologic surgery and has not as yet been employed sufficiently to determine its true value.

11. Two or more of the above procedures may obviously be combined; for example, arthroplasty and plastic procedures for the elongation of extra-articular contractures.

The selection of the procedure to be employed depends largely upon the structure and relation of the bones comprising the articulation, as demonstrated by the roentgenogram, and also the etiologic factor of the pathologic process. There may be extensive bone atrophy, more or less loss in continuity, sub-articular cysts

Fig. 20. Fig. 21. Fig. 22.

Fig. 20. Ankylosis of knee following monarticular infectious arthritis. Figs. 21 and 22. Same patient as shown in Figure 20, after arthroplasty of knee.

and cavities, sequestra, and extensive hypertrophy or condensation which may obscure cysts, cavities, or sequestra. When there is osteoporosis, bone structure should be restored as nearly to normal as possible before operative measures are employed. This can be accomplished by active use, unless gross deformity prevents, when correction of deformity is required as a preliminary step to permit active use of the part. In some instances the desired operation may be carried out, after which the return of normal bone structure is gradually induced by apparatus that permits only partial active use, as weight-bearing. If there is extensive loss in continuity, the reconstruction of any type of articulation that will permit function may be impossible, and such measures as osteotomy or fusion are usually indicated. When articular cysts or cavities are present, often a new base for an articulation cannot be reformed; thus restoration of function may be impossible. In such cases, if no symptoms are present and the part is in the most serviceable position, no treatment is indicated, but if painful symptoms or malposition are present, operative measures are indicated. Sequestra and cavities visible on the roentgenogram through dense bone are frequently potential foci of dormant infection which may be relighted by operation. Also, pus cavities in the soft tissues and those entirely obscured by condensation and hypertrophy, not demonstrable by the roentgenogram, may be found at operation when not suspected.

Joints often react to different etiologic factors in a very similar manner. Therefore, differentiation by the roentgenogram is often difficult or impossible but is usually suggestive if not conclusive, as in bone tumors; the diagnosis may not be made by any one element, but may require an accurate history, roentgenogram, and biopsy. Often the history is obscure and

we must depend almost entirely upon the manifestations as demonstrated by the roentgenogram.

In ankylosis resulting from intra-articular infection, the manifestations in bone are confined to the articular surface and to the subadjacent bone for a short distance only. In fibrous ankylosis there is more or less condensation of the extremities of the bone which stand out in marked contrast to the structure of other bones of the extremity, or of the joint of the normal side; the joint line is visible though narrow. Osseous ankylosis presents the same appearance though exaggerated, and there is no visible joint line after the lapse of one year. By functional adaptation the marrow cavity after several years may encroach upon the joint so as to form a central canal connecting adjacent bone. When this occurs, the success of reconstruction operations is more doubtful, as there has been coincident functional atrophy of the muscles, and function cannot easily be restored. Also, foundation for a new articulation is not always available.

In ankylosis, as a result of extensive osteomyelitis, the causative agent is usually the same as in pyogenic infection, but the structure for a considerable distance is of dense eburnated bone which bears the same relation to normal bone as dense scar tissue does to normal soft tissues. The circulation is deficient and the quality of such bone is poor. Also, infection is dormant and may be relighted by any surgical procedure; therefore, reconstruction operations for the restoration of function are positively contra-indicated.

In attenuated pyogenic infections there are destructive changes, with condensation and erosion of the articular surfaces. The joint line is plainly visible, the sub-adjacent bone is normal, and some motion is present. In this type, operative reconstruction gives very favorable results.

In osteo-arthritis, or the hypertrophic type of arthritis, and in atrophic, rheumatoid, or progressive polyarticular ankylosing arthritis, the manifestations are characteristic, well known, and require no discussion.

In syphilis there is increased density, hypertrophy of the periosteum and cortex, and definite punched-out areas of the articular surfaces, but differentiation can frequently be made by the Wassermann test.

The tuberculous joint is not under discussion, but as reconstructive surgery is usually contra-indicated when tuberculosis is the etiologic factor, differentiation is very necessary. In uncontaminated tuberculous joints, osseous ankylosis is very rare. There is usually a definite joint space with erosion, and at times destructive areas beneath the surface. Atrophy is more extensive in tuberculous joints; therefore, the bones comprising the articulation are relatively much smaller than those of the opposite side when compared with other affections. In tuberculous joints which have been contaminated with pyogenic organisms, differentiation may be impossible, as the characteristic reaction of such infections may completely obscure the tuberculous process. However, there are usually some of the characteristics of a tuberculous lesion and a pyogenic infection associated, as described above.

In most instances in the residual stage of arthritis the diagnosis by the roentgenogram alone is not required, as physical signs and past history are valuable evidence, and if combined with pathology, as demonstrated by the roentgenogram, an accurate diagnosis is usually possible.

In all types of arthritis there is a material danger of deformity which in many instances causes total disability and can be prevented by efficient apparatus that will permit ambulation. Also, deformity in the early stage can be corrected by the simple measures described above. The roentgenologist is often in the rôle of consultant, and, therefore, in a strategic position to advise orthopedic measures which will frequently prevent irreparable damage. Also, when much damage has occurred, he should be able to determine

the feasibility of relief by radical operative measures.

During the past decade there has been an intensive study of arthritis, and more interest has been manifested by the general profession, which is undoubtedly giving much better results than in the past. This is due to more efficient treatment by measures well known and not to any new specific remedy.

Arthritis is not in the province of any one specialty, but requires close co-operation of the internist, various other specialists, the orthopedic surgeon, and the radiologist, if success is to be attained.

THE RELATIVE VALUE OF RADIOTHERAPY, PHYSICAL THERAPY, AND HYPERPYREXIA IN THE TREATMENT OF ARTHRITIC DISTURBANCES[1]

By J. CASH KING, M.D., *Memphis, Tennessee*

IT HAS been pointed out that arthritis is a constitutional disease in which the inflamed joints are only a symptom. Also that the use of physical energies constitutes only a part of the armamentarium employed in combating this disease. In arthritis, as in tuberculosis, we have no specific, but careful study and intelligent application of the many therapeutic measures has resulted in great progress in the management of the disease.

It would be impossible to describe here the indications, advantages, and disadvantages of the procedures making use of physical energies. Therefore, I wish to limit my remarks to generalities influencing the effectiveness of this type of treatment.

RADIOTHERAPY

The relative value of radiotherapy in arthritis is small. Its application reaps its greatest results in the painful, actively infected joints, and not in the very chronic, mildly active cases: the result is the relief of pain. This relief is quite similar to that obtained with radiation in the treatment of superficial infections, such as boils, carbuncles, etc. The analgesic action is probably through the influence on terminal nerves and upon the leukocytes that have already gathered at the site of active pathology, thus greatly augmenting the resolution of inflammatory reactions that have not become organized. The rays produced by high voltage currents that are well filtered have given the best results, in my experience, and they are considered safer. Since this is a chronic condition, a word of caution might be spoken against the prolonged use of radiation. It must be remembered that there already exists an impaired vascularity in the affected parts.

PHYSICAL THERAPY

This is probably the oldest form of therapy known to man. After years of neglect and even abuse it is being revised, restudied, and utilized more prudently by orthodox medicine in the treatment of arthritis. Pemberton has remarked that: "In no other disease has it a greater application than in arthritis, and heat, massage, and exercise constitute a triad without which few or no advanced arthritics can expect to recover."

The rationale of the influence of these measures is through their effect upon the following physiologic disturbances that accompany arthritis: impaired circulation; frequent sub-normal metabolic rate; impaired function of the intestinal tract; anatomic deformities and muscle atrophy that result in joint distortion; dry thickening of the skin over the affected joints. A knowledge of the influence that physical energies exert on these changes and the manner in which they influence them constitutes the most outstanding prerequisite of successful treatment. This might be compared to the axiom set forth by someone: "It is more important to know what sort of patient has a disease than what sort of disease a patient has." It appears that too much importance has been placed upon the technic and too little study on the physiologic changes produced by physical therapy.

The local application of heat to the affected joint causes dilatation of the vessels; improves the circulation of the blood and lymph; lessens pain, and permits a greater range of motion. Systemic exposure to heat increases the metabolic rate, induces profound sweating, and greatly accelerates the entire circulation,

[1] Presented before the Radiological Society of North America, at the Twentieth Annual Meeting, in Memphis, Tenn., Dec. 3–7, 1934.

An extemporaneous address presented in the absence of the speaker to whom this subject had been assigned.

particularly that in the subcutaneous tissues. It also induces alkalosis, which with extreme application leads to tetany.

The methods of producing localized heat are too numerous to even mention here, but they may be divided into three major groups: (1) dry heat or baking; (2) hydrotherapy or moist heat; (3) diathermy or other high frequency electrical energies.

HYPERPYREXIA

Any of the above-mentioned forms of heat will produce an elevation in the general body temperature to a greater or lesser degree, if the body is insulated against dissipation of this heat. Besides physical energies, numerous toxic substances familiar to all have been used to produce febrile reactions in arthritis. The physiologic changes associated with fever caused by toxic agents differ from those associated with fever by physical energies. The differences and merits of each have been discussed at length in the literature during the last few years. It is my belief that fever produced independent of toxic agents combats more effectively the pathologic changes of arthritis.

Within the last five years much enthusiasm, and in my opinion too much enthusiasm, has been exercised in the use of physical energies in the treatment of arthritis. The error occurred because of the hope and through the efforts to find one form of treatment that might cure arthritis independently of other established beneficial measures now commonly used. I do not feel, however, that the entire responsibility for this error should rest on the shoulders of the physical therapist and others reporting results with these measures. The authorities on the subject of arthritis have been too slow in recognizing and utilizing these agents for their true value. In estimating the value of any treatment it must be remembered that arthritis is one of the diseases in which remissions may occur with little or no treatment, which undoubtedly is responsible for the great number of treatments offered and the claims made for each throughout the history of medicine.

In conclusion, I wish to say that the relative value of radiotherapy, physical therapy, and hyperpyrexia in the treatment of arthritis is in direct proportion to the understanding of the physiologic changes produced by these agents and the willingness of the physical therapist to co-operate with the internist, surgeon, and radiologist in an effort to give a patient the full advantage of each service.

MEDICAL ASPECTS OF CHRONIC ARTHRITIS[1]

By RALPH A. KINSELLA, M.D., *St. Louis*

MY PART in this symposium is to help to lay out for you the purely medical aspects of this problem of chronic rheumatism. In that way I shall avoid the surgical and orthopedic aspects, leaving the discussions of them to others.

There are several groups of chronic arthritis in the clinic, the most common being degenerative and rheumatoid arthritis. The roentgenologists have had a lot to do with the terminology of chronic rheumatism; the words "atrophic" and "hypertrophic" may have been derived from the x-ray appearances in these two main groups of arthritis. The hypertrophic, or the degenerative, variety has these two names because, in the roentgenogram of this type of arthritis, there seems to be a hypertrophic change. This change is revealed as protuberances and excrescences on the edges of bones making up joints; there is no loss of bone substance and, in general, the picture looks like one of production.

However, it has been found that in all individuals past the age of forty the wear on the joint surfaces brings about a gradual degeneration of the facing cartilages and at the same time, due to the forces of weight-bearing and traction by heavy muscles, a pulling out of the edges of the bones, so that these protuberances or excrescences are made up of true bone. The word "degenerative," therefore, is applied because the initial phase in the development of this type of arthritis is a degeneration, a splintering of the cartilage facing the joints. The words "hypertrophic" and "degenerative" are interchangeable.

With regard to the other type of arthritis, the so-called atrophic or rheumatoid, there have been many names. As students, we learned about this condition as "arthritis deformans." The first penetrating investigation of the subject is recorded by Nichols and Richardson as far back as 1909. They were much impressed by the fact that the earliest lesion seemed to arise in the synovia, first as a round-celled reaction and later as a fibroblastic reaction, which spread from that point into the joint cavity, smearing over the surfaces of the bone like a pannus, at the same time gripping the ends of the bones in the same sort of process, and leading to the absorption and disappearance of calcium. This gives the ends of the bones a rarefied appearance and that is probably the source of the expression "atrophic." Nichols and Richardson preferred the word "proliferative" because the condition seemed to be entirely a chronic proliferative process.

The process is not unlike that of infection as it has been studied in experimental animals, when a more acute infecting agent, such as hemolytic streptococcus, has been used to produce arthritis. In this experiment the initial lesion likewise is in the synovia, outside the cavity, around the blood vessels, and spreads from that point into the joint cavity, running over the surface of the ends of the bones like a pannus, invading the underlying bone, spreading into the surrounding tendons and muscles, and finally being replaced by scar tissue which contracts and produces ankylosis by fibrosis. This is the only experimental arthritis which simulates the course of events in rheumatoid arthritis in humans and the idea that rheumatoid arthritis is possibly some kind of an infectious arthritis is sound. What kind of an infectious arthritis has not yet been determined.

The disappearance of the lime in the ends of the bone, and the rarefication of the bone-ends generally, is apparently due not only to the disuse that these joints

[1] Presented before the Radiological Society of North America, at the Twentieth Annual Meeting, at Memphis, Tenn., Dec. 3–7, 1934.

necessarily suffer but also to the actual absorption of calcium due to the pathologic process.

Beside the degenerative and the rheumatoid, or atrophic, arthritis, a very common chronic type which comes into the clinic and the hospital is the chronic infectious arthritis that begins as an acute gonorrheal rheumatism. I wish to refer to this only briefly because its treatment is surgical and not medical. I am stepping outside the bounds by discussing treatment, which I believe is chiefly surgical, but this type of chronic arthritis is usually the result of an acute surgical condition.

I feel strongly that, in those cases in which it is known that the process is purulent, outside the joint, and in which the course will be chronic, prognosis is extremely unfavorable if that purulent focus is not immediately drained. There is ample experience to show that if the original focus is immediately drained, the infection is removed from the body and the future of the patient is secure. Of course, that does not mean that every case of gonorrheal rheumatism with a thin, straw-colored, copious effusion is a surgical case. We can distinguish between those cases that have copious, thin effusion in which it is extremely difficult to find any gonococcus, from those cases that are infiltrative around the joint, with dense, brawny, and exquisitely tender flesh, and in which gonococci are found with comparative ease both in smear and on culture. These more simple cases which seem to be almost non-bacterial can be expected to run a favorable course without any surgical procedure and get well in a few weeks without much of any special kind of treatment. But the other type, in which there is dense infiltration of the tissues surrounding the joints, in which very little fluid may be obtained out of the joint cavity itself, such fluid as is obtained being very purulent and easily yielding gonococci both in direct smear and on culture, is comparable to an abscess any place in the body, and harbors a focus which, if not removed, may be the feeding point for arthritic change in many other points. Nothing is more unsatisfactory to treat than the case of a chronic gonorrheal rheumatism involving many joints.

With regard to the hypertrophic or degenerative variety of chronic arthritis, I have already described the pathologic changes that may be found. I have indicated that the process is thought to begin as a degenerative splintering of cartilage facing the joint cavity, as a result of the pressure of weight-bearing. This process occurs normally in all individuals past the age of forty, and even in those persons who have no arthritic symptoms. As such, it is purely a degenerative process and might be said to be a healthy person's disease. It is aggravated by any mechanical force which tends to increase the pressure on the weight-bearing cartilages, so that obesity, occupation, or orthopedic disturbances anywhere in the joints that affect the carriage of the body will aggravate and accentuate this development.

I have spoken also about the x-ray appearances of these joints. These robust types of individuals may go on for years without any particular disability, and when at last they come into the clinic the diagnosis is usually easy. It is usually a healthy-looking, robust, hypersthenic type of individual who comes in with one joint involved, usually the knee joint—some important weight-bearing joint—and the problem is often that of associated diseases as well as the particular problem of the joint itself.

It is difficult to say to what degree an infectious process is associated with the production of disability in this type of joint, but it is quite likely that in cases in which there is acute, red swelling about a joint in a patient of this type there is some infection in the body—in our experience most often in the urinary tract—which has something to do with a transplantation of infectious material or agent in the neighborhood of one joint.

As far as the x-ray is concerned, the evidence is not different in one of these

disabled joints from that in the corresponding joint on the opposite side which is not disabled. The fundamental process beginning in middle life continues to a greater or less extent in all joints and the joint that is disabled is usually so because of some peculiar and non-associated process. Infection is rare as a cause of disability in this type of patient; the most common causes of disability are mechanical forces, injury, and the mechanical disturbance incident to bad shoes or fallen arches.

The treatment we carry out in the arthritis clinic of the Firmin Desloge Hospital is almost entirely that of physical therapy. Of course, these patients also have what might be called an orthopedic survey. It happens that our arthritis clinic is conducted jointly by the Department of Medicine and the Department of Orthopedics, so that there is the greatest amount of co-operation and exchange of ideas in this field. These patients often need corrective orthopedic treatment which in itself, is sufficient to bring about proper carriage of weight and relief from disability.

The part that physical therapy plays seems to be important. At least, after these patients have gone to the Department of Physical Therapy for several months, they usually drop out of the clinic and we do not see them again for perhaps a year. Patients of this type tend to get better—they stop coming to the clinic, and feel that their treatments received in the Department of Physical Therapy were important in bringing about an improvement.

These treatments are of the kind which are most familiar and they range from diathermy, which the patients seem to like, to various types of massage and the application of heat by lamps. The drugs that we use for this type of patient are colchicum, because it sometimes happens that there is the factor of gout confused in this particular type of rheumatism, and the salicylates, for their analgesic effect. In general, we feel that a patient coming into the clinic with this type of rheumatism has a favorable outlook; he can usually be returned to work.

The other type of chronic rheumatism, which is by far the most important because it is the most dramatic and the most tragic, is the so-called rheumatoid arthritis or atrophic arthritis. I have compared the sequence of events outlined by Nichols and Richardson in their study of early cases of rheumatoid arthritis with that sequence of events which occurs in experimentally produced arthritis in animals and have shown that there is a parallel between the acute infectious processes in an animal and the chronic process in the human. What the etiology of rheumatoid arthritis is, remains unknown. The most recent investigations have shown that the cellular reaction in the tissue just outside the joint cavity is suggestive of the cellular reaction found in acute rheumatic fever and, because the disease is frequently febrile in its early stages and locally shows redness and swelling around the joints, the expression "chronic rheumatic fever" is being used more frequently.

The mechanism of production of this type of rheumatism in humans is remarkably similar to that of acute rheumatic fever and gonorrheal rheumatism in that all of these types of rheumatism seem to depend for their beginning on the interposition of some shocking event. In the case of acute rheumatic fever, this event seems rather definitely to be some infection such as a sore throat, scarlet fever, and (it is said) even injury. Gonorrheal rheumatism is never seen immediately after an acute gonorrheal urethritis; it comes at some later day and usually follows something like an upper respiratory infection—a streptococcal sore throat, gastro-intestinal poisoning, and not infrequently an injury.

In the case of rheumatoid arthritis, it is very common to have a history of the first joint becoming involved following a drastic shock, a nervous shock of some sort—the loss of an important member of the family, a great fright, a devastating infection of some sort, and also injury.

So, the production of these forms of arthritis is somewhat similar and it reinforces the idea that rheumatoid arthritis is probably an infective process.

As was said at the very beginning of this paper, it is extremely unfortunate that to-day we have no special message with regard to the treatment of rheumatoid arthritis. However, it ought to be emphasized that treatment, whatever it is, is very important as contrasted with none at all. Whatever the local joint-display may be in these patients, the thing that is of most importance is that as human beings they are tremendously discouraged, suffering from pain and weakness. For that reason, therefore, it is important that some routine of treatment should be employed; it is surprising how much improvement may be obtained in any given case even if ultimate cure cannot be expected.

I wish to refer to one routine of treatment that we use in the Firmin Desloge Hospital.

Our idea is to keep the patients occupied, having them visit the Department of Physical Therapy twice a day. In the morning they receive some sort of bath, which may be a cabinet bath, the packing of the body in blankets, or the immersion of the body in hot water: any maneuver which succeeds in bringing about a general reaction of the skin is the one that is used, and it is not always the same one in all patients because they seem to have their preferences. We have, in a few cases, resorted to artificial fever, but one apparently unfavorable effect has led us to be extremely careful in the use of this procedure.

Then, during the day, these patients are given something to do with their hands, some form of occupational therapy, of which there are many about a hospital. In the afternoon they again go to the Department of Physical Therapy and receive bakes and massage. The effect on the morale of the patients is remarkable; they come into the hospital usually late in the disease, after several years of disability, considerably discouraged, and every effort made in their behalf seems to them to be cheering and beneficial. They are encouraged to walk and helpers are available who walk them up and down the corridors regularly and improve the range of the use of joints.

The most important treatments reported in the literature to-day are those with various types of vaccines. There is more work going on in this field than in any other therapeutic field with regard to this type of arthritis. There are several kinds of vaccines, the most commonly spoken of being the ones made from the hemolytic streptococcus. I am not sure that any special kind of streptococcus has been used; the reports indicate that certain forms have been used—usually those obtained from the patient or those obtained from some other worker who has kindly supplied what he calls a "typical" strain.

But the whole question of the etiology or rheumatoid arthritis with reference to hemolytic streptococcus is still unsettled. There are very many reports which indicate that streptococci of some variety may be obtained from the blood and joint fluids of patients with rheumatoid arthritis, but there are just as good reports to show that these results are not accurate. However, the problem must remain in a state of doubt at present, for the reason that there probably is no special strain of streptococcus to be used as a vaccine in the treatment of this type of rheumatism.

We have treated during the past year at the Firmin Desloge Hospital, eight patients by intravenous inoculation of hemolytic streptococci. We have not gauged the doses by the skin test, a method which is advised in the latest writings. However, our doses have been such as could have produced favorable results if the treatment was the proper kind. We have not been impressed by the results. The temporary periods of improvement are not unlike those that seem to attend any form of treatment.

One of our associates, Dr. Muether,

has been interested in recovering from the urine of these patients a proteose which he then gauges by skin tests with regard to the use of this material for vaccination and, beginning with subcutaneous doses and continuing with intravenous doses of proteose, 15 patients have been so treated in the past year, with the same sort of conclusions—that there are phases and periods of improvement and, in general, nothing to encourage the further use of this agent. Most recently we have been making vaccines from streptococci recovered from the throats of such patients, using these vaccines intravenously after determining their potency with regard to skin sensitivity, and we find that the patients seem to improve for a time, just as they did in the other forms of treatment.

Now the drugs that are used in the treatment of this type of rheumatism are chiefly salicylates, which are used for their analgesic effect, and sulphur. It is easy to condemn their use, to say that they do no good, but they do relieve pain, and those practitioners who use large doses of salicylates by rectum are much impressed by the amount of good they are doing simply because they do relieve pain. No sulphur has been used in the arthritic clinic of Desloge Hospital but a great deal of it has been used in the orthopedic clinic, and, as I said, the departments of medicine and orthopedics are joined in the study of arthritis.

We cannot feel that, in this type of rheumatoid arthritis, the use of sulphur has done anything in a very important way. I suppose that 50 or 60 patients have been treated with as many as from 75 to 100 injections of sulphur. The very fact that so many injections are used is an indirect argument against the value of the drug.

The Department of Orthopedic Surgery renders valuable service in the relief of these patients. There is a form of treatment in vogue in many parts of the country which consists of putting the contracted joints in casts at night during sleep, the idea being that these patients tend to flex their joints to the greatest extent during sleep and, when they awaken in the morning, suffer a great deal of pain and disability in the attempt to straighten out these joints, with the result that they do not straighten them out and ankylosis progresses, and the fixation of the joint in an ectopic position is emphasized. This form of treatment is a very important one in our experience at Desloge Hospital.

I wish merely to refer to an experience that we have had with regard to the surgery of the sympathetic nerves and the injection of femoral arteries with alcohol in the treatment of this particular kind of rheumatism. There have been about thirty-five cases of rheumatoid arthritis treated by sympathectomy—lumbar sympathectomy—which has been done usually on one side for the purpose of studying its effect on the pain and the movement of joints on that side in the lower extremity. Curiously, our first results were so good that before the investigation was over about thirty-five patients had submitted to this operation. However, we do not advise it because subsequent results did not justify its continuation. The relief of pain was not constant. The improvement in the movement of joints, which was due to the relief of pain, was therefore not constant, and the procedure was finally discontinued.

We then thought that we might imitate the same effect by exposing the femoral artery and then packing the tissue around it with alcohol. Here again the first one or two cases in whom we resorted to this procedure were relieved of pain in the joints on the same side and, therefore, used these joints with greater freedom, but later cases did not show this sort of improvement.

In speaking of the prognosis of this type of rheumatism there are two things that are extremely important, one being that these patients tend to have remissions. Bearing that in mind, any sort of treatment that is offered must be criticized because the improvement that is ascribed to the treatment may be an improvement that the

patient might enjoy without such treatment. The other point is that the disease subsides; it finally stops being painful and every effort should be made before that time to keep the body moving and to conserve as far as possible the function of the joints, so that if—and when—the disease stops the patient may find himself not a complete cripple.

The treatment of arthritis is palliative, like the treatment of cancer, with its palliative surgery or palliative roentgen radiation, which brings comfort to the patient in some way and for that reason is essential.

DISCUSSION OF SYMPOSIUM ON CHRONIC ARTHRITIS

DR. ROBERT S. STONE (San Francisco): The duties of a roentgenologist may be divided into three: in the first place, he has to diagnose specific lesions in specific parts of the body; in the second, he has to treat specific lesions in specific parts of the body, and in the third place, he has to act as a consultant on the general condition of the patient who happens to have the lesion he is either diagnosing or treating.

I feel that this symposium has been well arranged in that it gives us a chance to see all the different sides of this question in regard to arthritis. One sometimes wonders of what value it is, in a radiological symposium, to have a paper on the medical management of arthritis and one on the surgical management of arthritis, but I feel that these are subjects that we should know more about than we do.

When a patient is brought in to an x-ray department or an x-ray office by such a man as Dr. Campbell, there is no question about the judgment of the man who has charge of the patient or about what he should do for the patient. If the patient is brought in by a medical man of the standing of Dr. Kinsella, there is no question but that he is going to have the proper management. However, we all have doctors who refer patients to us—doctors who do not know so well these diseases or their management. Seeing the patient very early in the course of the disease, we should be able to offer advice or suggestions to his doctor which may help the latter and lead to the prevention or the correction of deformities, or induce him to refer the patient to one who can give the proper medical management.

I think that our duties as roentgenologists extend far beyond just describing the morphological condition that is present. We are consultants, and must be prepared to discuss therapy as well as diagnosis. I am very glad, therefore, that we have heard these papers, which give us a better insight into what can be done and help us to advise those who are not specialists in these conditions.

DR. JACQUES FORESTIER (Aix-les-Bains, France): I ask permission to bring to you two points to make this discussion very short and, if possible, effective. The subject has been so well covered that there is no necessity to discuss further any of the points brought out here, but I would like to call your attention to two points, one diagnostic and one therapeutic.

The diagnostic point deals with the question of calcification in the spine, which seems to have some importance, and I want to illustrate[1] that there are two types of anatomical changes which may be detected by x-ray in the spine and which are very often confused, at least in my country, and lead to quite different clinical pictures.

The first type of change is what is generally called "osteophyte" or "bony spur." The second type of change is what my chief, Sicard, and I have called "syndesmophyte."

[The first slide shown] is a typical picture of the osteophytes in the cervical region. You can see the lipping of the two vertebral bodies and you can see that there is a space between them, too, in spite of the fact that they seem to go one against the other.

[The second slide shown] is another os-

[1] Slides were shown but not left with the Editor for reproduction, and that part of the discussion based upon them will, therefore, lack clearness to those readers who were not present at the meeting.

teophyte in the dorsal region. It is very important to notice that in these two cases it is the same bone formation; it is a spur which belongs to the vertebral body, which is a growth arising from the bony tissue itself, from the cancellous tissue, and which is also covered by a cortex. This is a bony formation from the bone itself. It is the osteophyte. It is a type of change which has been described here and which does not lead to ankylosis. It is of degenerative nature and should be classified in the group of hypertrophic arthritis.

On the other hand, here [third slide] is quite a different form of ossification, of calcification, at the anterior edge of the vertebræ. You see that it is a small linear shadow which is much less dense than that of the vertebral body which is not in continuation with the bone itself but is an addition, a calcification which has developed inside the vertebral ligament and will soon unite the two adjoining vertebræ. We call it "syndesmophyte." It is most important to note the difference between these two forms of changes because this last form leads more or less, sooner or later, to ankylosis of the spine.

On the patient [shown in the fourth slide] you see on the right side the spinal column in its cervical segment; on the left side the lumbar region. In each of them you see syndesmophytes; that is to say, the type of bone formation which belongs to the ligament and not to the vertebral body. This is the ankylosing type, which is very well illustrated by the fact that in the lumbar region you can see similar calcifications of the ligaments which are not osteophytes but syndesmophytes, and which have brought about a full ankylosis.

The last point which I want to emphasize about treatment is that in an experience of over ten years in the treatment of arthritis I have almost entirely discarded the use of vaccines. It seems to me that in a chronic disease, even if it is infectious, the fact that the disease is chronic proves that the body is unable to make any spontaneous reaction against the infection, so that it is quite useless to try to increase a sort of reaction of defense which does not exist at all.

Vaccine therapy is a logical procedure every time the disease has a tendency to wear out by itself, and it may bring about a better and quicker cure by stimulating some reaction which is existent but too small; but it is unable to bring about a curative reaction when there is no reaction at all from the body. This is the reason why, for six years, I have been using a chemical therapy which has proved, in France and in some other countries of Europe, to be more effective than many other chemical therapies. That is the use of gold salts.

I have given a few discussions of this subject in this country and I want to emphasize the fact that the gold salts therapy gives remarkable results when it is carried out in conjunction with the auxiliary treatments—physical therapy. In France and elsewhere in Europe we use very much the spa treatment with the natural mineral hot waters. When this gold salts treatment is carried out for a sufficient length of time, it is able to bring about cures which are not obtainable by other forms of treatment.

DR. CAMPBELL (closing): In 1916 in an article entitled "Osteospondylitis," before the Orthopedic Section of the American Medical Association, I described the manifestations defined by Dr. Forestier as "localized syndesmophyte." They are areas of calcification beginning in the center of the intervertebral ligaments, and may later fuse with the margins of the vertebræ above and below. The condition I described was very acute and some of the cases were sequelæ of acute infectious diseases, as pneumonia.

A typhoid spine may react in the same manner. This osseous reaction I have always regarded as the result of inflammatory changes in the intervertebral discs.

Syndesmophytes differ from osteophytes in that they may form a complete osseous bridge with osseous ankylosis, while osteophytes are merely marginal proliferation and do not cause a continuous growth uniting two vertebræ.

CONGENITAL LUNG CYSTS IN INFANTS AND CHILDREN

By SAMUEL GEORGE SCHENCK, M.D., *and* JACOB L. STEIN, M.D.,
Brooklyn, N. Y.

From the Radiological and Pediatric Departments of the Jewish Hospital

PULMONARY cysts of congenital origin are considered a very rare condition. Up to 1925, Koontz (1) was able to collect 108 cases based on autopsy findings, all of which were published in the European literature. His case report, however, was not the first to appear in the American periodicals. In 1913, Pappenheimer (2) described the necropsy of a seven-months premature infant with multiple congenital cystic cavities in the right lung. The child was cyanotic and made some feeble efforts to breathe; he lived for only three hours under artificial respiration. In 1919, Koeckert (3) described an enormous cyst filling the greater part of the chest in a new-born infant who lived for only two hours, with symptoms of cyanosis and marked dyspnea. The microscopic study of the walls of the cyst revealed its bronchial origin. Since 1925, 120 new cases have been collected from the world's literature, 49 of which have been verified by necropsy. This apparent increase of reported cases is due to the fact that clinicians, stimulated by Koontz's paper, are more on the alert to recognize the condition. In addition, roentgenologic technic has been improved considerably, with the result that many new cases have been discovered during life which might otherwise have passed unrecognized. The following interesting case prompted this report.

R. S., a male infant, weighed seven pounds four ounces at birth. Labor was normal and the delivery spontaneous. The infant cried lustily at birth. There was no history of illness during the first weeks of life, however, on Aug. 9, 1933, at the age of five weeks, the patient was seen because of insufficient gain in weight, which was then eight pounds four ounces. The child appeared well developed, and on physical examination there was no evidence of any pathology in the chest or elsewhere. The thorax was symmetrical, and both lung-fields were apparently negative to percussion and auscultation. However, routine roentgenoscopic examination of the chest revealed a large, circular, dense shadow occupying the middle of the right lung bed.

The roentgenograms (Fig. 1), taken on the following day, showed a well circumscribed area of opacity situated in the right pulmonary field and occupying about one-half of the lung space. The pulmonary apex and base were clear, and the left lung bed was normal. No displacement of the heart and mediastinal structures was noted. The lateral view (Fig. 2) showed the ovoid area of opacity to be intrapulmonary, and not part of or connected with the mediastinum or pleural cavity. The roentgen impression was congenital fluid lung cyst, not connected with a bronchus.

The infant was again seen on Aug. 19, 1933, at which time his weight was nine pounds eleven ounces, showing a gain of one pound five ounces in 10 days. Since the first visit, he had coughed up brownish fluid, otherwise, the patient had no other symptoms. There was no elevation in temperature, breathing was not rapid, and cyanosis was absent. The intradermal tuberculin test (Mantoux) up to 5 mg. was negative. Follow-up roentgen examination (Fig. 3) at this time portrayed a definite, clear zone, indicative of air, occupying the upper half of the ovoid opacity in the right lung, and the presence of a fluid level in its lower half. It was felt that a solitary cyst had ruptured into a bronchus at the time when the child had the above-described coughing spell and the brown viscid fluid was raised.

On Sept. 3, 1933, the patient was again observed, at which time he showed a gain of two pounds three ounces in 15 days, and

Fig. 1. Roentgenogram taken on Aug. 10, 1933. Dense ovoid area of opacity is observed which lies in the middle of the right lung bed and occupies more than half of the pulmonary field. The right apex and base are clear. The heart is not displaced. The findings suggest a solitary fluid cyst.

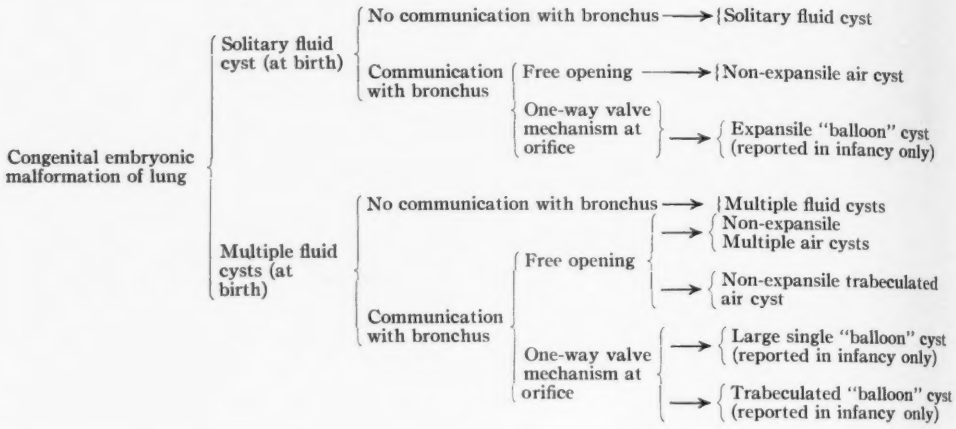
Fig. 2. Roentgenogram taken on Aug. 10, 1933. Lateral view of the chest shown in Figure 1. The dense oval opacity is clearly seen lying within the lung-field. Its anterior border merges with the cardiac shadow and its posterior surface extends to but does not lie in the posterior mediastinum, which appears clear.

was symptom-free. Roentgenographic study (Fig. 4) portrayed a curvilinear shadow in the right lung, about the same size as noted on the last films, with an entirely clear central zone. No retained fluid was observed; air occupied the entire cavity, the walls of which were moderately thin. When observed again, two months later, all the encapsulated air had disappeared, the walls were absorbed, and the lung markings appeared normal. The child continued to gain in weight, and appeared well nourished and healthy in every respect. Repeated examinations (Fig. 5) failed to disclose any abnormal or pathologic findings. Observed for over a year and a half, the child remains well and symptom-free.

Comment.—This case represents a solitary non-expansile fluid cyst in an infant five weeks old, with no symptoms referable to the chest. During a bout of vigorous coughing, the infant raised some thick tenacious fluid. When roentgenographed later, the cyst revealed air and a horizontal fluid level, which suggested a rupture of the cyst into a neighboring bronchus or bronchiole. Finally, the cyst, entirely replaced by air, collapsed and the lesion spontaneously disappeared.

Classification.—From the clinical standpoint, the classification of congenital lung cysts suggested by Anspach and Wolman (4) is very satisfactory. Most classifications are based on the pathogenic characteristics or on the etiologic factor. Daniels and Jezsovics (5) considered congenital cysts or congenital bronchiectasis to be localized or diffuse, and as agenetic (Kaufmann, 6), atelectatic (Heller, 7), or idiopathic (Bard, 8), depending on what the writer believed to be the etiologic basis of the lesion. Far more practical from a clinical viewpoint is the classification recommended by Anspach and Wolman (Table

TABLE I.—SUGGESTED CLASSIFICATION OF CONGENITAL LUNG CYSTS ON THE BASIS OF POST-NATAL BEHAVIOR (ANSPACH AND WOLMAN)


Congenital embryonic malformation of lung
Solitary fluid cyst (at birth)
No communication with bronchus
Solitary fluid cyst
Communication with bronchus
Free opening
Non-expansile air cyst
One-way valve mechanism at orifice
Expansile "balloon" cyst (reported in infancy only)
Multiple fluid cysts (at birth)
No communication with bronchus
Multiple fluid cysts
Non-expansile Multiple air cysts
Communication with bronchus
Free opening
Non-expansile trabeculated air cyst
One-way valve mechanism at orifice
Large single "balloon" cyst (reported in infancy only)
Trabeculated "balloon" cyst (reported in infancy only)

I); they considered that all congenital cysts, whether solitary or multiple, contain fluid at birth. Wolman's (9) six-months stillborn fetus had fluid in the bronchogenic cyst. Pappenheimer (2), Kessler (10), Grawitz (11), Koeckert (3), Hückel (12), Melchior (13), Tyson (14), Smith (15), Collins (16), Swanson, Platou, and Sadler (17), and others have also described infants with fluid cysts.

At birth, a solitary fluid cyst may or may not communicate with a bronchus. If it does not, it remains as a solitary fluid cyst, comparable with a cyst elsewhere in the body. However, if it communicates with a bronchus, it will present one of two pictures: air and fluid with a fluid level, or a cavity with air alone. If a free communication between the cyst and the bronchus exists, and air is allowed to enter as well as to leave the cavity through the communicating orifice, the cyst will not increase in size or "balloon." This is the so-called non-expansile air cyst. If, on the other hand, air enters the cavity and becomes locked in so that it cannot easily escape, the cyst enlarges or "balloons," becoming an expansile or a "balloon" cyst. The inability of the air to escape is due to compression of the communicating bronchus by the cyst, resulting in a one-way valve effect at the orifice. This mechanism has been clearly shown by the autopsy records reported by Jacobs (18), Nelson (19), and others.

As in solitary fluid cysts, so in multiple fluid cysts at birth, there are those which communicate with a bronchus and those which do not, the effect being the same as in a solitary cyst. If the multiple cysts have a bronchial outlet, the nature of their communicating opening will determine whether or not they become expansile. With a free orifice they do not expand, but if the bronchial opening admits air and yet is closed during the expiratory phase due to pressure from without, the findings may reveal a large single solitary balloon cyst or a trabeculated one.

Although there are no available statistics on the incidence of lung cysts, it appears from all reports that the condition is rare. Lenk (20) observed six cases in 10,000 roentgenologic examinations of the chest. One of the writers (S. G. S.) has recognized only one in about 25,000 roentgen studies of the chest. Polayes (21) failed to find a case in over 3,000 autopsies which included many infants. In patients 15 years of age or younger, 106 cases have been collected altogether. Pulmonary cystic disease was recognized in 26 patients at birth; 41 were under one year of age, and in the remaining 39 the lesion was discov-

Fig. 3. Roentgenogram taken on Aug. 19, 1933. The dense shadow in the right lung now shows a clear zone in its upper half, suggesting the presence of air, which has replaced some of the fluid in the cystic cavity. The presence of air indicates a rupture of the cyst into a neighboring bronchiole.

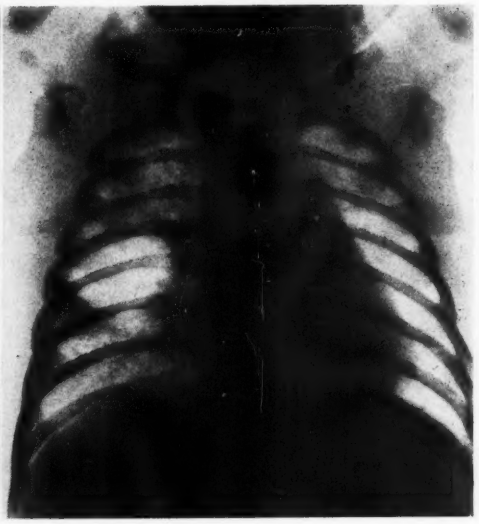


Fig. 4. Roentgenogram taken on Sept. 3, 1933. In place of a dense shadow or an opacity with a clear translucent zone, there is now present a large spherical area of clarity in the midportion of the right pulmonary field. Air has replaced all of the fluid in the cyst. The wall of the cavity is clearly shown and appears to be moderately thin.

ered between the ages of one and 15 years. Sex apparently plays no rôle in the incidence. Of the patients in whom the sex was mentioned, 36 were males and 42 females. The right and left lungs are about equally affected, contrary to the previously expressed opinion that the lesion predominates in the left lung. The right lung was involved in 35 patients, the left in 39, and the lesion was bilateral in 23 children. Single or multiple congenital lung cysts vary in size considerably. A solitary cyst may be so large as to occupy the entire pulmonary field, extending from apex to base and even beyond the midline, compressing the lung to a mere shell in all directions, displacing the heart and mediastinal structures well to the opposite side, and flattening the diaphragmatic dome on the affected side. The compiled cases are divided into the following types: solitary non-expansile fluid cysts, 21; solitary non-expansile air cysts, 12; solitary expansile or balloon cysts, 21; multiple non-expansile fluid cysts, 23; multiple non-expansile air cysts, 26; multiple expansile cysts, 2.

Etiology and Pathology.—The etiology and pathogenesis of congenital lung cysts are still obscure. Many theories have been advanced which do not satisfactorily explain all the cases. The fact that so many synonymous terms, such as atelectatic bronchiectasis, congenital bronchiectasis, telangiectatica, bronchiolectasis, fetal bronchiectasis, congenital cystic malformation of the lung, honeycombed lung, etc., have been used to describe various cases indicates the different interpretations placed on the nature and origin of the pathologic condition. Some observers even question the fact that all cases are congenital, yet the evidence is overwhelmingly in favor of such a conclusion. A brief résumé of the various theories of some prominent authors follows:

The condition was described by Heller (7), in 1885, as a congenital atelectasis, due to the failure of the normal lung at birth to expand, which results in the lack of alveolar development, compensated by the widening of the neighboring bronchi. Francke (22) also reported his case as a congenital

atelectasis. Atelectatic bronchiectasis or aplasia of the alveoli is recorded in the cases described by Orth (23), Heuter (24), and others.

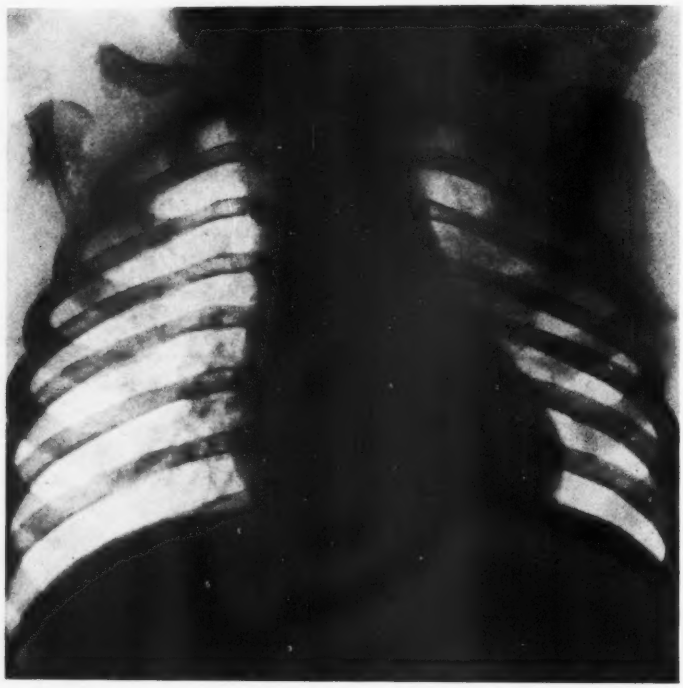


Fig. 5. Roentgenogram taken on Aug. 17, 1934. The air cyst and its surrounding wall are entirely gone. The lung-field is clear and the peribronchial markings are not exaggerated or pronounced, and appear to be the same as on the left.

In 1862, Virchow (25) considered the pathogenesis as dilatations of the lymphatics. The mesothelium-lined cysts scattered through the interstitial pulmonary tissue were regarded by Klebs (26) as lymphangiectatic. These defects of aplasia and hypoplasia are caused by a developmental error. Grawitz (11), in 1880, described the lesion as a congenital bronchiectasis due to faulty anlagen of the lymph-vessel system of the corresponding lobes of the lung.

In 1914, Heuter (24) believed that the lesion is the result of a stenosis or closing off of the bronchial branches. The earlier the process develops, the fewer and larger the cysts; the later, the more numerous and smaller, so that some lungs have a honeycombed appearance. Swanson, Platou, and Sadler (17), in 1928, agreed with Heuter that the developmental error is probably a stenosis of a bronchus or bronchiole, claiming that the secretions in a cyst can cause marked distention and distressing symptoms. Miller (27) questioned the rationale of this theory, maintaining that a retention of secretion, the escape of which is blocked by strictures of the bronchioles, can hardly be the actual cause. This assumption is substantiated by the fact that a communication with a bronchus is frequently demonstrated; the epithelium is not always flattened; there is no apparent pressure atrophy of the intervening septa, and the secretion found in the cavity is not sufficient in amount to cause distention.

Koontz (1) noted that the cyst is caused by a constriction of the walls of the bronchus with a dilatation of the parts distal thereto. The basis for the excessive development of the mucous membrane, which forms the constriction in the bronchus, was unknown to him and is evidently a developmental anomaly. Microscopically, he noted two general types: cysts which appear like bronchial retentions, with concentric muscle fibers and cartilage in their walls, which are lined with stratified ciliated columnar epithelium, and cavities which resemble emphysematous blebs lying subpleurally. Although most cases are lined with ciliated polygonal epithelium, many other types of epithelium have been described, as cuboidal cylindrical with or without cilia. Small and medium-sized cysts are principally lined with many-layered ciliated columnar epithelium, whereas the larger ones have flat or cuboidal cells. Elastic and fibrous tissue, smooth muscle, and pieces of cartilage are also generally found. Clear albuminous fluid, desquamated epithelial cells, lymphocytes, pus, or mucus in the lumen of the cavities are often found in different cases. The absence of pigment or anthracosis is an important finding which indicates the congenital origin of the lesion.

Koontz made the observation that often an excess of elastic tissue and smooth muscle frequently appears in tumor-like masses. In 1897, Stoerk (28) believed that fetal bronchiectasis is due either to an inflammation which produces bronchial stenosis, with a retention of the secretions, or to an increase of the interstitial or peribronchial fibrous tissue which retains its fetal characters. He considered the lesion as neoplastic and termed it fetal cystic bronchial adenoma. In Hückel's (12) first case of cystic disease in a stillborn, he described the presence of glandular proliferations invaginating the cystic cavity, and regarded the pathology as resembling bronchial adenoma. In 1929, Altmann (29) described the excessive growth of the interstitial connective tissue. Löhlein (30) was of the belief that the process is neoplastic. Cystic adenomatous malformations in a six-day-old infant were described by Couvelaire (31). Buchmann (32) noted epithelial and muscular proliferation, which he interpreted as neoplastic transformations. Although in certain of the cases collapsed tubular epithelial projections into the cystic cavity resembling glands are described, structures which provoked Stoerk's suggestion that the lesion is adenomatous in character, nevertheless, Miller (27) regarded their occurrence as apparently not constant and not an essential part of the lesion.

The French observers were inclined to regard congenital syphilis as the underlying cause. In 1907, Sandoz (33) believed that the faulty development of the alveoli from the small end-bulbs of the bronchial tree in the embryo is due to congenital syphilis. Oudendal (34), in 1928, considered the developmental anomaly to be caused by fetal adhesions between the parietal and visceral pleuræ, fetal infection with syphilis being given as the possible cause of these adhesions. He did not consider neoplasm as the likely etiology. However, since syphilis is frequently absent, this impression is not tenable.

The British authors did not regard the condition as of congenital origin. In 1907, Box (35) believed that the lesion developed as a sequel to bronchopneumonia. Bernstein's (36) theory expressed a similar belief, in which he stated that the following sequence of events takes place: acute bronchitis; bronchiolitis; peribronchitis; bronchopneumonia ending in dilatation of the terminal bronchioles, and infundibula. However, the present consensus of the investigators is that cavities obviously result from an anomaly in development rather than from an acquired disease as bronchopneumonia. Although these patients have an increased susceptibility to intercurrent disease due to their congenital lesion and may die of pneumonic infection, it does not necessarily follow that the cysts are the result of this infection. On the other hand, it is more likely that pneumonia not infrequently complicates the underlying cystic

condition which completely masks the basic lesion for a time, as occurred in Eloesser's (37) case. Of the 86 cases reported in infants and children who were subjected to autopsy, only 25 showed pneumonic lesions. The necropsies of patients reported by Ribadeau-Dumas and Rault (38), Hückel (12), Wood (39), Fleming (40), Cautley (41), Wolman (9), Pappenheimer (2) and others showed no evidence of inflammatory changes.

Other theories as to the causative factors in the development of pulmonary cysts have been expounded. In 1927, Sauerbruch (42) mentioned the possibility of pressure and constriction across the hilus of the embryonal lung-bud by a duct of Cuvier occurring early in development. Smith (15) believed that dilatations of the atria, the openings into the bulbous terminations of the bronchioles, to be the cause, since he found no elastic or muscle fibers in the walls of the cyst on microscopic examination. The malformation was not recent enough in origin to be dilated alveoli, because these cells are not formed until the sixth fetal month. De Lange's (43) theory, expressed in 1927, considers the etiologic basis as an underdevelopment of the alveoli, which is compensated for by a widening of the bronchi. This developmental error involving the alveolar tissue interferes with the normal support of the bronchi, as a result of which they become unduly dilated.

Miller (27), in 1926, was of the opinion that the change affects the finer bronchioles, but not the larger bronchial branches, thus distinguishing cysts from bronchiectasis. Even though a certain amount of smooth muscle and cartilage is found in the walls of the cysts and is scattered through the intervening tissues, nevertheless, Miller felt that the cause is entirely obscure but obviously a result of a developmental error. In 1934, Wood (39) was also inclined to believe that many of the theories advanced do not satisfactorily explain all of the cases, and that the true cause is still unknown. Nevertheless, he was of the opinion that the origin is congenital.

In 1931, Parmelee and Apfelbach (44) believed the cyst to be an enormously dilated bronchial radicle or a huge bronchiectasis, probably developing as follows: a small congenital bronchiectatic cavity, which produces no symptoms and no abnormal physical conditions at birth, gradually increases in size as the infant breathes, resulting in a one-way valve mechanism that readily allows air to enter the sac and inflate it, but does not allow a corresponding deflation to take place. As the sac grows in size, the bronchial radicle and radicles leading to it become more and more tortuous as they are compressed toward the hilus, thereby increasing the interference with deflation. Finally, respiration and circulation are embarrassed sufficiently to produce dyspnea and cyanosis. The histologic studies indicate that in almost all cases the cyst wall has the characteristics of a bronchiole, and the defect in the development of the bronchioli is of embryologic origin. In 1932, Nelson (19) entertained similar views. He considered that the malformed bronchi, with readily collapsing walls, may become partially obstructed by increasing the intrathoracic pressure, allowing a valve-like action with the ingress but not the egress of air up to a point at which rupture of a cyst occurs, with the production of a temporary pneumothorax and an improvement in the clinical condition.

The theory advanced by Parmelee and Apfelbach (44) was also supported by Croswell and King (45). However, Anspach and Wolman (4), in 1933, criticized this explanation, and logically expressed their own views. If the cyst enlarges by forcing its way peripherally through the surrounding lung tissue within the short space of a few weeks, one would expect, therefore, to find a greatly stretched thin-walled capsule and flattened lining due to the quick increase in size. Instead, however, these cysts have the opposite structure, namely, a thick fibromuscular capsule and well developed columnar epithelial lin-

ing. The probability is that they all had a similar beginning, that is, rupture of a fluid-containing cyst. The presence of a well developed wall and of an entering bronchiole substantiates this conclusion. Rupture and evacuation must then have occurred soon after birth. In Anspach and Wolman's study of the pathogenesis, most cysts possess a lining of cuboidal epithelium supported by fibrous tissue, smooth muscle, and cartilage, and seem to be bronchogenic in character. The histology resembles a lymphangioma ramifying through the alveolar septa. The primary pathologic picture is often confused by the complications within the lung cyst, as infection, rupture, etc. Anspach and Wolman maintained that "cysts found in early infancy are true congenital malformations, arising from several different sources in embryonic life. However, once a large cystic cavity has been formed, its behavior should be determined largely by mechanical and accidental influences, such as capsular strength, proximity of adjacent air passages, plasticity of the surrounding lung tissue, and the presence or absence of complicating respiratory infections, rather than by its embryogenesis or histology of its lining."

Anspach and Wolman's case was originally a large fluid-filled cyst, its fluid content disappearing while under observation, presumably due to a rupture into a bronchiole. Some mucoid material was expectorated, the remainder apparently having been swallowed. The fluid in the cyst was replaced by air. Due to the valve-like effect of the bronchiolar opening, which permitted an ingress but no egress of air, the sac, instead of collapsing, dilated or ballooned out. This expansile mechanism accounted for the respiratory difficulty which eventually caused death. These changes were followed roentgenologically, and verified at necropsy.

The writers' case can well be explained in a similar fashion, the findings fitting in so well with the above description that it appears to be the only tenable explanation. When first studied with the roentgen ray, the infant's chest showed a fluid-containing cyst with no air. After the child coughed up thick, gelatinous material, the roentgenograms showed the presence of air and a fluid level, indicating that the cyst had ruptured into a neighboring bronchiole. However, no expansile enlargement of the cyst took place, as in Anspach and Wolman's case, because the channel between the bronchiole and the cyst was apparently patent in inspiration and expiration. The fluid, however, was entirely evacuated and replaced by air; all that remained was a solitary non-expansile air cyst. This finding remained unchanged until its walls finally collapsed and absorbed—the patient made an eventual recovery.

Symptomatology.—Many cases of congenital lung cyst are symptom-free for many years, and may be unrecognized until late in life, if at all, provided that no complication or intercurrent condition ensues which necessitates a detailed physical and roentgenologic examination. The most common symptom of congenital pulmonary cysts, especially in infants and children, is the presence of recurrent attacks of dyspnea. This may be so mild as to be almost overlooked, or so severe as to cause profound fear of impending death. The severity of the breathlessness will depend on the size and type of the cyst. A solitary cyst communicating with a bronchus, which admits the air and produces a one-way valve mechanism at the opening, accounts for the most profound attacks of dyspnea, which often require thoracentesis to relieve the air tension in the cyst cavity. This is the so-called expansile or balloon air cyst, which may become very large, resulting in compression atelectasis of the surrounding lung, shifting the mediastinal contents to the opposite side, and depressing the diaphragmatic leaf. These patients usually expire in an attack. Such cases are recorded by Miller (27), Swanson, Platou, and Sadler (17), Nelson and others. Multiple cysts of the lung do not as a rule produce marked dyspnea. When bilateral and extensive, they may cause slight respiratory embarrassment, which may often pass unnoticed. However, if these multiple

cysts communicate with a bronchus which allows the air to pass only one way, they form a trabeculated ballooned cyst, which produces symptoms similar to those present in patients with solitary expansile cysts. The case reported by Hünermann and Sievers (46), and Miller's (27) second case, illustrate this type.

Accompanying the dyspnea, cyanosis is a prominent symptom, varying degrees of which may be observed by the parent, or discovered on examination. Cough is a very variable symptom and is often absent. It apparently never plays a very prominent part; however, cough and expectoration are important symptoms in watching the progress of a case. The sudden onset of a bout or "fit" of coughing in the infant reported by the writers, with the expectoration of thick brown fluid, is significant, as it was in the case described by Anspach and Wolman (4). It indicated a rupture of the cyst into a neighboring bronchiole and the displacement of the contents of the cyst by air. The authors' case developed free communication between the cyst cavity and the bronchus and remained non-expansile. However, Anspach and Wolman's patient formed an imperfect opening which did not allow the air to escape from the cavity during expiration. The result was an expanding or balloon cyst which caused severe respiratory difficulty and eventually death.

The expectoration occasionally may be blood-tinged or frank hemoptysis may occur. Pearson (47) reported a case of hemoptysis in a girl 14 years of age with multiple cystic cavities in the left lung. Usually, however, bloody expectoration is more frequent in adults suffering with congenital bronchiectatic lesions or multiple air cysts.

Other symptoms of congenital lung cyst in children are noted in the presence of complications which ofttimes mask the congenital condition completely. Probably the main complication is the presence of pus in the cavity, which may result in an elevation of temperature, but is usually not alarming in degree because of the localization of the purulent fluid. Frequent coughing attacks are the rule, and, if a bronchus is in communication with the locked pus, a purulent expectoration is present. The symptoms of a pneumothorax, partial or complete, are present when an expanding cyst ruptures into the pleural cavity. Among the less common symptoms of cystic lung are anorexia and vomiting, each of which was present in five patients of the entire series.

The physical signs in a large solitary cyst are different from those present in multiple cysts; the presence or absence of fluid is likewise a factor. The connection of the cavity with a bronchus with or without a free channel also affects the nature of the physical signs. Occasionally, no signs are present. Wood (39) reported a solitary non-expansile fluid cyst in a child one year of age who had no signs in the chest, the discovery of the cyst being an accidental roentgen finding. Paviot (48) described at necropsy a solitary non-expansile air cyst in a young girl who died of typhoid fever. The pulmonary lesion gave no symptoms or signs during life.

A well-developed solitary balloon cyst presents the signs of a pneumothorax. On inspection, the affected side bulges and moves poorly on respiration. The apex beat is displaced considerably. Percussion reveals hyper-resonance over the affected area and a shift of the heart and mediastinal structures to the unaffected side. Dullness over the compressed lung is usually elicited; breath sounds are diminished or even absent, and râles are often heard in the region of the compressed lung. These signs vary when air and fluid occupy the cavity, and the signs of a localized hydropneumothorax are elicited. If the cyst which contains air and fluid occupies the entire side of the chest, as in Anspach and Wolman's (4) case, the findings simulate a general hydropneumothorax.

Multiple cysts or cystic degeneration of the lung, unilateral or bilateral, present the physical findings of bronchiectasis. The signs depend on the number and size of the cavities as well as on the presence or absence of mucus or pus.

The blood picture is normal, except for a slight or moderate anemia which may or may not be present. Some degree of leukocytosis is noted in patients with infected cysts. Although malnutrition may be present (malnutrition was sufficiently evident to be recorded in 12 of the collected cases), the general condition of the patient is often good. In 20 of the infants and children, other congenital deformities were found beside the cystic malformation of the lungs. An anomalous development of the lung was the most frequent abnormality—the anomaly was usually an accessory lobe or lung which harbored the cystic defect. Diagnosis by the subjective and objective findings alone is rather difficult, and a review of the reported cases shows that the diagnosis was missed considerably more often than not. Roentgen study is by far the most reliable means of diagnosis during life, although the symptoms and signs should at least suggest the possibility and should be borne in mind when a complete roentgen examination is made.

Roentgenological Findings.—The roentgen study includes not only vertical and prone views as well as a lateral study, but also a painstaking roentgenoscopic survey. The findings are single or multiple cavities with thin walls in one or both lungs, containing fluid or air or both. If sufficiently large, the surrounding lung is compressed and airless. The heart and mediastinal shadows are displaced to the unaffected side, and the diaphragm is depressed on the involved side. In multiple cavities, one or both lungs appear honeycombed with trabeculated cystic areas. Differentiation from massive or localized hydropneumothorax, tuberculous cavitation, atelectasis, acquired bronchiectasis, lung abscess, encapsulated fluid, and pulmonary consolidation may be difficult. The surrounding capsule with its clear-cut curvilinear borders aids in establishing the diagnosis. Lateral views show the process to lie within the lung-field. Unilateral emphysema, caused by a non-opaque foreign body, such as a peanut in the bronchus, especially when the foreign body produces a ball-valve effect, must, not infrequently, be excluded, and may necessitate a bronchoscopic examination. Nevertheless, a careful and thorough roentgen survey and a detailed history will, in most cases, rule out these conditions and establish the diagnosis of pulmonary cysts. Before the advent of roentgenography, the condition was seldom, if ever, recognized during life. When observed on the autopsy table, it was viewed as a pathologic curiosity, and had little or no clinical significance. Wood (39), who observed 16 cases, diagnosed six entirely on the basis of the roentgenologic findings, and is of the opinion that a large percentage of all cases can be so recognized.

Diagnosis and Differentiation.—The recognition of pulmonary cysts in children depends partly on the symptoms, less on the physical findings, and chiefly on the roentgen study. Recurring attacks of dyspnea with varying degrees of cyanosis are usually present in large cysts. Cough may or may not be present, and is seldom a prominent symptom. These symptoms without the history of a previous respiratory infection should put one on his guard. If the cyst is large and contains only air, hyperresonance and diminished breath sounds are elicited, the heart being displaced to the normal side. Local dullness is present and breath sounds absent when fluid fills the cavity. Small cysts may cause no symptoms or physical findings.

The roentgenologic findings are important and often establish the diagnosis. When fluid is present, the cyst appears as a dense ovoid shadow surrounded by normal lung. The diagnosis can often be confirmed by the aspiration of milky, viscid fluid, the nature of which differentiates it from encapsulated fluid from other causes. The fact that the patient is an apparently healthy infant will point more toward a lung cyst. In a large balloon air cyst, pneumothorax is to be ruled out. In the former condition a moderately thin capsule is present and the cavity lies within the lung. The surrounding lung is compressed from all sides, toward the apex, toward the base and costophrenic sinus, and toward

the lung root, which shifts with the mediastinal structures to the opposite side. In generalized pneumothorax, the air lies without the lung which collapses toward the hilus, so that the apex and sinus are free from lung tissue. The lung root and mediastinum are likewise shifted contralaterally, but the root is not thinned out as in a large lung cyst, but appears rather like a dense stump which represents the collapsed lung. In addition, no capsule surrounding the air is present. Roentgenologically, multiple cysts are recognized by their honeycombed appearance simulating acquired bronchiectasis, from which they must be differentiated. Further study by bronchoscopy and by the injection of iodized oil into the bronchial tree may be required to establish the diagnosis.

The history, symptoms, and a thorough roentgenologic investigation, occasionally requiring visualization of the bronchial tree with opaque oil and rarely necessitating bronchoscopy, will help, in almost all cases, to exclude other possibilities. Conditions such as cystic diseases of an acquired nature are to be considered and must be excluded. Echinococcic cyst appears usually in the right lower lobe, and after rupture may show characteristic hooklets in the sputum. The complement fixation test and the presence of an eosinophilia aid in their differentiation. Dermoid cysts usually begin after puberty and often originate in the anterior mediastinum. Occasionally, they rupture into a bronchus or into the pleural cavity or the lung itself. Dermoid cysts, teratomas of the mediastinum, and mediastinal cysts occur most frequently in the third decade of life and form dense adhesions to the neighboring structures. In a case of a dermoid cyst, the presence of teeth or bone may be demonstrated on the roentgenogram, or hair may be found in the expectorated material. Hydatid cysts are also usually mediastinal in location and produce little dyspnea. If rupture occurs, the watery nature of the fluid is rather characteristic, and hooklets and fragments of membrane may be present in the expectoration. Congenital pneumothorax is an extremely rare condition and can be differentiated from a huge solitary balloon air cyst in the same manner as acquired generalized pneumothorax, discussed above. Solid tumors may offer some difficulty at first. A chondroma or a ganglioneuroma presents sharp borders and is seldom confused with a cyst filled with fluid, the borders of which are rather poorly defined. Occasionally, it is necessary to induce a pneumothorax to establish the diagnosis. This procedure was employed in two of Wood's (39) patients with telling effect. The outline of the cyst within the partially collapsed lung is clearly portrayed and easily recognized. The patients reported by Hünermann and Sievers (46), and by Swanson, Platou, and Sadler (17) also demonstrate the lung cyst in the presence of an induced pneumothorax. Diaphragmatic hernia or eventration can readily be excluded by means of the oral administration of barium. In addition, the physical signs vary and gurgling sounds are frequently heard in the patient with the herniated lesion.

Prognosis.—An analysis of the reported cases clearly shows a high mortality in infants and children. In the 51 cases of congenital cystic diseases in infants and children collected since 1925, 35 are dead. The patients reported by Croswell and King (45), Vollmer (49), Zarfl (50), and the new case described in this communication are the only four on record that have completely recovered and show no trace of the former condition roentgenologically. There are patients, however, who live for years with few or no symptoms, but with no change in the roentgen appearance of the cyst. Several adult patients have been cured by the surgical removal of the cyst, but, because of their age, surgery has not been attempted on infants and young children. Melchior (13) removed successfully what he considered to be a dermoid cyst in the left lung of an eight-year-old girl. On examination, the cystic tumor proved to be a congenital tracheo-bronchial cyst. Although adults may live for many years with pulmonary cysts, in infants the condition presents the

gravest outlook and frequently results in early death.

Treatment.—No specific treatment can be offered. Many cases present a surgical problem, and future thoracic surgery in infants and children must meet the challenge. Thoracentesis has been performed, with temporary improvement, and a one-way cannula which permits only the exit of air has been left *in situ* for several days, a procedure which is of only transitory benefit. Such a cannula was employed by Miller (27), Swanson and his co-workers (17), and others, with temporary relief. Croswell and King's (45) case had repeated aspirations with a one-way tube, and recovered. Although Vollmer's (49) patient had one aspiration after which the cyst eventually disappeared, the author did not believe that the thoracentesis should be credited with the cure. In Zarfl's patient, who was a seven-months-old boy with a solitary air cyst, puncture was almost decided upon when the symptoms began to subside and thus intervention was rendered superfluous. The child experienced three severe episodes of high remittent fever, and exhibited diffuse râles in the chest. These attacks, which lasted from three to eight weeks, occurred in rapid succession. With the subsidence of the symptoms, the cyst appeared reduced in size and, finally, disappeared entirely five months later. The writers' patient recovered without any treatment. Inasmuch as many of these children live only a short time, with or without repeated thoracentesis, a reliable therapeutic procedure is in order. There is no treatment in the diffuse honeycombed type of cysts.

SUMMARY

Stimulated by the recent literature, more and more cases of congenital lung cysts have been reported in the last decade. Although their etiology is still obscure, the opinion prevails that we are dealing with a congenital malformation or developmental error, which results in a dilatation of the terminal bronchiole filled with a tenacious glairy fluid. If the cyst communicates with an adjacent bronchiole, this fluid is replaced by air, and may remain stationary in size, provided the communication is patent during both phases of respiration. If the air is allowed to enter the cystic cavity, and the communicating channel collapses or is closed off during the expiratory phase, the cyst enlarges or balloons, thereby producing severe attacks of dyspnea and cyanosis, which often terminate in death. A similar mechanism obtains in the case of multiple or honeycombed cysts.

The diagnosis is made chiefly from a complete roentgenologic survey, and the condition must be differentiated from general or localized pneumothorax, lung abscess, encapsulated fluid, pneumonia, solid tumors, and acquired cystic disease such as bronchiectasia, echinococcic cyst, and hydatid cyst. The prognosis is very grave, especially in infants, and only four cases are recorded to have made a complete spontaneous recovery. No specific treatment can be offered, although the opinion is expressed that surgical removal will some day be a feasible procedure.

CONCLUSION

A case of congenital solitary lung cyst in an infant is reported. The cyst ruptured into a neighboring bronchus, evacuated its fluid contents, which were replaced by air. Subsequently, the cyst walls collapsed and were absorbed, with the infant making a complete recovery.

The literature on congenital lung cyst is reviewed, and the various theories of its pathogenesis are outlined and discussed. A logical classification for this anomaly, suggested by Anspach and Wolman, is presented. The symptomatology, diagnosis, differential diagnosis, prognosis, and treatment are discussed as completely as our present knowledge on the subject permits.

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GRAPHICAL METHOD FOR OBTAINING THE AREA OF THE HEART SHADOW IN THE ROENTGEN-RAY STUDY OF HEART DISEASE

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CLINICIANS for the most part agree that the size of the heart is a good index to its anatomical and functional status, consequently, accurate determination of the size of the heart in relation to cardiac disease has been a subject of considerable importance. The size of the heart may be determined by the following methods: percussion, palpation, and the roentgen ray.

By percussion it is possible to outline the left border of the heart and the width of the upper sub-sternal dullness, but it is very difficult to determine the right border of the heart. However, under normal conditions the determinations may be relatively accurate, but if the individual is obese and deep-chested or if an emphysematous thorax is present, this method is of little value, because percussion usually includes a certain portion of the lateral surface of the heart.

Bedford and Treadgold (2) believe that the only clinical method of any particular value in determining heart size is the location of the apex-beat by palpation. The procedure they advise is the location of the place on the chest wall at which a definite lift is imparted to the finger tip, and not the point farthest to the left at which the cardiac pulsation is perceptible. This determination must be made when the heart is beating at a normal rate, and quietly, because in the presence of anemia, or Graves' disease, the apex beat will be more diffuse, and consequently the size of the heart will be increased. This method is applicable in subjects of normal build, but it is very inaccurate in the obese types or in those possessing emphysematous chests, for the larger the heart, the less reliable will be the clinical apex beat as an index of actual size. The roentgen ray offers the opportunity of viewing the heart from every angle, and various planes of the cardiac silhouette which may be performed in the following several ways:

1. The heart may be visualized in various positions with the aid of the fluoroscopic screen. By this method it is possible to note the size of the chest, rhythm, regularity, amplitude, and motility of the heart in various postures and during respiratory phases, but actual measurement is impossible and a permanent record is not available (2 and 3).

2. A film of the chest may be obtained at a distance of six or more feet from the focal point of the x-ray tube, with the patient in various positions. In ordinary cardiac roentgenology, these two methods are usually sufficient and offer the additional advantage of an objective record with the shortest expenditure of time (14).

3. Orthodiagraphic tracings of the heart borders and the internal surface of the thorax in various positions are used extensively.

4. Teleradiography involves taking a radiogram of the chest with the film two meters from the tube.

5. Palmieri (13) suggests making a plastic model of the heart carried out in two different phases, the first, consisting of roentgen photographs taken with artistic technic in the different radiating directions, and the second, consisting of plastic synthesis.

6. Klason (10) recommends orthoprojection of the heart registered on a horizontal plane, with the patient in an upright position. By comparing the projections thus obtained with an ordinary orthodiagram a good idea is obtained of the relative sizes of the four chambers of the heart. This method has its greatest

value when it is a question of estimating the size and shape of the ventricles.

7. A new method which is called orthophotography, devised by Tamiya (15), is based on the principle that a specially constructed tube emits roentgen rays in two opposite directions, one beam being used for the actual roentgenoscopy, while the other registers the findings on a roentgen film mounted on the back of the tube box. This permits the tracing of the borders of the heart on the screen (orthodiagraphy) and the simultaneous registration on the roentgen film (orthophotography).

In general, the above-mentioned methods are most commonly used, giving preference to orthodiagrams in the determination of the size of the heart. The frontal plane of the cardiac silhouette is the surface evaluated with an estimation of the volume, size of heart cavities, determination of diameters, area of the surface of the shadow, and the latter two often correlated with body measurements.

The following consists of brief statements of various methods and determinations. An estimation of the volume of the heart is proposed by Kahlstorf (9), with the following formula: V = F.t.k., F being the surface of the sagittal orthodiagram; t, the largest depth of the heart evaluated by using frontal direction rays; k, an empirically determined constant figure, 0.63, which, corresponding to the shape of the heart, lies between figures for an ellipsoid and a paraboloid. From this, the cardiac quotient is estimated, which is the volume of the heart expressed in cubic centimeters, divided by the body weight in kilograms. This quotient for normal men should not be below eight and in women not below seven. It is the author's opinion that the cardiac quotient furnishes quick information concerning the size of the heart and is of considerable value in differential diagnosis in borderline cases.

Chaumet (3) proposes the following procedure for the determination of heart size: (1) Orthodiagram of the heart, with determination of the index of the development of the depth of the ventricle; (2) total index of the left ventricle; (3) index of the right cavities; (4) surface. He believes that this method is rapid and convenient, for a few numerical figures express the respective development of various cavities.

Vaquez and Bordet (16) suggest the following two methods of determination of cardiac size: (1) By measure of the area of projection either by means of a planimeter or a sheet of paper ruled in millimeters on which one traces the figure and counts the number of square millimeters to which it corresponds; (2) by the length of the principal diameters, that is, longitudinal, transverse, and a diameter extending from the base of the left ventricle to the right cardio-diaphragmatic angle.

Host (8) devised a chart and correlated the transverse diameter, longitudinal diameter, width of the heart, surface, height, and body weight. He determined the surface of the heart by the rectangular figure constructed by the base as the longitudinal diameter of the heart, and the height by the width of the heart. He stated that comparative measures show that the surface of such a rectangle corresponds to the actual surface of the heart.

By completing the upper and the lower borders of the cardiac silhouette with the convex line, Moritz (11) believes that determining the surface area by planimeter is more important and has a greater value. However, he offers another method of estimating the surface area of the silhouette by the cardiac rectangle, which can be figured from the rectangular figure formed by the longitudinal and transverse diameters. Moritz then compares the surface area of the heart to other standard measurements of the body, such as height and ideal body weight. He states that the most constant results are obtained by comparing the surface area of the heart to the product of the height and circumference of the chest. The coefficient in 15 normal cases gave the average value as 20.1. In order to simplify things, 20.1 was considered equal to 100, thus all values were

expressed in relationship to 100. The minimum value in normal cases was taken as 86 and the maximum as 112. In pathologic cases the variation was between 112 and 180.

In further work by Moritz (12), he believed an increase in the body height was accompanied by an increase in the longitudinal and transverse diameter of the heart. The average longitudinal diameter of the heart was 14.2; the average transverse diameter 10.9 centimeters. He is of the opinion that the height of the body is a suitable measure for establishing a ratio to the longitudinal diameter of the heart.

Bedford and Treadgold (2) also correlate heart size with body size, their conclusions being as follows:

"The total transverse diameter is the most reliable index of heart size for practical purposes. Transverse diameter varies directly with body weight but not with height. At any given weight, transverse diameter varies inversely with height. Further, the normal transverse diameter may be predicted with reasonable accuracy from body weight in those [persons] whose height and weight must be taken into account in predicting heart size. This may be done by using tables based on formula, such as those constructed by Eyster and his co-workers, or the normal transverse diameter predicted from body weight may be corrected for height when this diverges from the ideal height for body weight."

Tables predicting cardiac area and transverse cardiac diameter have been prepared, based on body weight, stature, and age. Hodges and Eyster (7) computed the prediction formula for cardiac area from the measurements of 70 cases, as follows: Area in sq. cm. = age 0.0204 + stature 0.8668 + weight 0.337 minus the constant 03.8019. They concluded that if the heart is found to be 7 sq. cm. larger than the predicted area, the chances are 3 to 1 that it is actually enlarged.

Hodges and Eyster (6) prepared a table for the determination of normal transverse cardiac diameter derived from the following formula: $T.D. = 0.1094 \times A - 0.1941 \times H + 0.8179 \times W$ 95.8625, in which $T.D.$ equals transverse diameter, A age, H height, and W weight. They believed that if the heart is found to be 5 mm. wider in its greatest transverse diameter than the diameter, as predicted by the formula, the chances are 3 to 1 that the widening is pathologic.

These determinations were applied in a study of 424 cases of normals and cases with chronic heart disease, and it was found that measurements in clinical hypertrophy differ sufficiently from the normal to conclude that cardiac measuration is a valuable method for determining the existence of cardiac hypertrophy, and compares favorably with other useful methods applied to clinical medicine (4). In the normal series of cases only 9 per cent exceeded the prediction by more than 10 per cent, while in the pathologic cases 94 cases were more than 10 per cent above the predicted normal area. On the basis of the greatest transverse diameter, less marked separation could be made (5). These tables afford quick determination of the predicted dimensions, and to further simplify matters a slide rule has been devised which is time-conserving and very easily read.

Bainton (1) believes the prediction tables of Hodges and Eyster to be a fairly satisfactory guide in judging abnormality in the size of the male heart and in estimating the degree of enlargement; also, that the adjusted standard for females in which the figures for males is reduced by 0.8 cm. is equally satisfactory.

As has been previously stated, Moritz (11) and Eyster (5) believed the area of the cardiac shadow to be a very valuable estimation. Briefly summarizing, it may be determined by any of the following methods: planimeter, cardiac triangle, prediction formula based on body measurements, and calculation on millimeter paper.

The following is a graphic method for obtaining the area of the cardiac silhouette which is comparable with all others. The accuracy of the area thus obtained is sufficient for any case, and the cost of equipment is practically negligible.

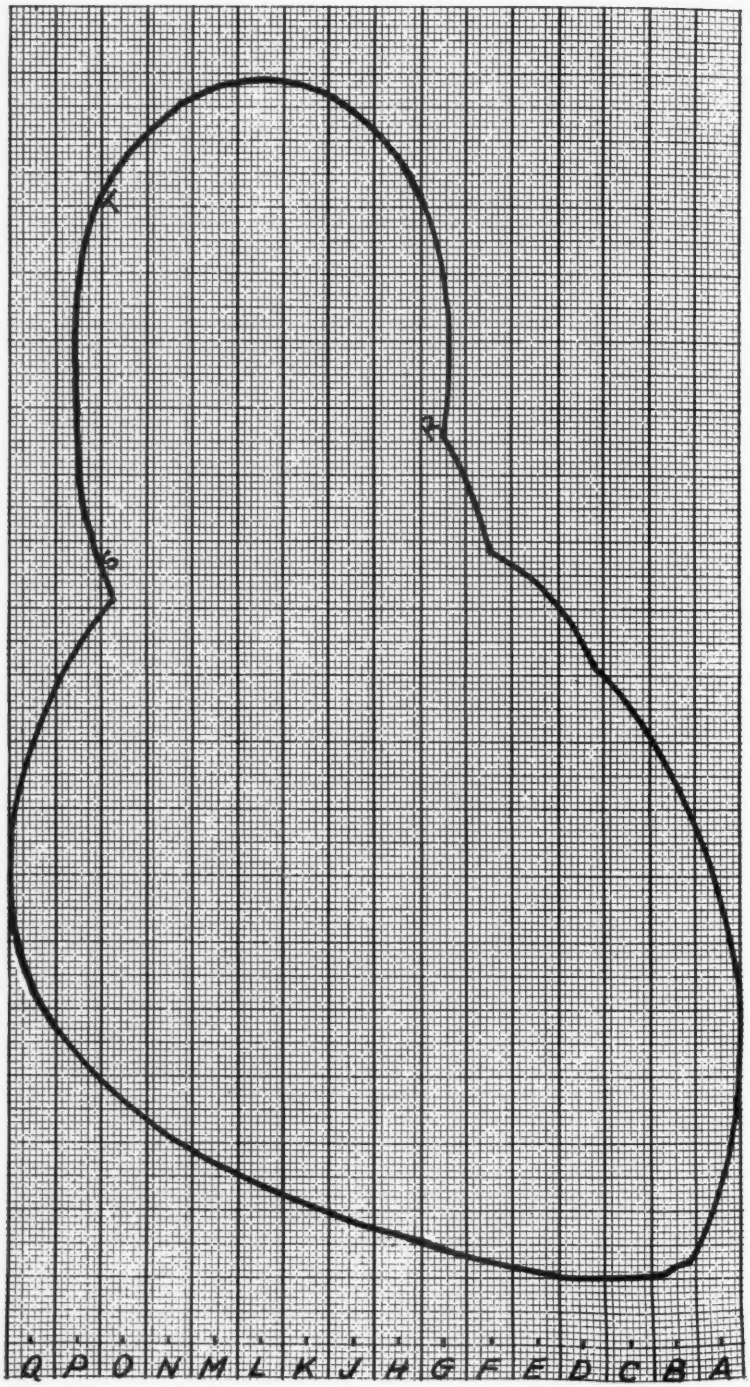

Fig. 1. Geometrical drawing of aortic and cardiac shadow, showing spacing arranged so as to compute area in centimeters. This may be used for any irregular surface.

The areas of irregular surfaces may be determined by Simpson's rule. The rectangular co-ordinate is placed over the heart shadow with the lines running vertically and horizontally, and with one of the heavy horizontal lines being tangent to the shadow at the apex. The upper and the lower borders of the heart are filled in arbitrarily. The heart shadow in this instance is divided into 16 equal strips (Fig. 1), but there may be any number for convenience. The readings are taken of the mean ordinates, that is, the ordinates in the middle of the strips. In Table I, the mean ordinates are added and multiplied by the width of the strip—7 mm.—which result is the required area.

TABLE I.—READINGS OF THE MEAN ORDINATES OF THE HEART SHADOW

Mean ordinate	Length of mean ordinate in mm.	
A	41	
B	71	
C	85	
D	95	Nearly half of strip is cut off
E	103	
F	110	
G	136	
H	162	Reading up to $R = 121 + 1/2$ of length above $R = 121 + 1/2$ of $29 = 135 1/2$
J	165	
K	166	
L	164	
M	159	
N	151	136
O	138	
P	58	
Q	33	
	1,837	

Area in sq. mm. $= 1837 \times 7 +$ area between S and T; Area between S and T may be taken as 2 mm. wide and 25 mm., mean ordinate, or 50 sq. mm. Therefore, the total area is:

Area in sq. mm. $= (1837 \times 7) + 50 = 12{,}909,$

Area in sq. mm. $= \frac{12{,}909}{100} = 129.09.$

The other methods for determining area by the heart shadow rectangular method are: (1) Calculating the length of the even and odd ordinates separately and computing the results as above, or (2), which is a more complicated procedure, consisting of determining the areas of all the trapezoids and adding them. In addition, the polar method may also be used as a check on the entire area of the heart shadow including the aorta, as obtained by the rectangular co-ordinates, and especially to separate the area of the aorta from that of the heart shadow proper. All of these methods will give the same result, but the first method is by far the easiest and the least complicated.

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CHANGES IN SUSCEPTIBILITY OF *DROSOPHILA* EGGS TO X-RAYS

II. CORRELATION OF BIOLOGICAL ACTIVITY AND RADIOSENSITIVITY

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WHY tissues and cells are differentially susceptible to radiation is one of the fundamental questions in radiology. It is a remarkable fact that some cells can withstand very large doses of radiation while others succomb to very small doses. For example, Crowther (1) has shown that around 80,000 roentgens of x-rays are required to inactivate a certain protozoan (*Colpidium*), whereas Scott (2) has found that cells of the chick allantois are destroyed by two or three roentgens. Although the tissues of the human body probably do not manifest such wide differences in radiosensitivity, they do nevertheless differ considerably and it is largely upon this condition that the beneficial results obtained in radiotherapy depend.

In an earlier report (3) we have shown that the radiosensitivity of *Drosophila melanogaster* (fruit fly) eggs changes abruptly and over wide ranges during early development, and have also pointed out the bearing such changes have on quantitative radiobiological results. Since the nature of developmental activity is different at different stages it has been possible also to correlate changes in radiosensitivity with changes in biologic activity and thus ascertain what conditions in the organism are associated with radiosensitivity. Such procedure has yielded information concerning the factors which determine susceptibility to radiation. Therefore, we wish at this time, to take up in some detail the biological conditions at the different stages and show their relation to radiosensitivity.

Early Development in Drosophila Eggs.—The mature *Drosophila* egg consists of a cell wall or vitelline membrane within which are the single egg nucleus and many yolk granules suspended in a semi-fluid protoplasm (Fig. 1-*A*). Surrounding the egg is the egg case or chorion which is secreted by ovarian cells and which is lost at the time of hatching. As the eggs pass through the vagina of the female fly they are capable of being fertilized by spermatozoa which have been stored by the male in the seminal receptical. Sperm enter the egg and one sperm nucleus unites with the egg nucleus to form the segmentation nucleus. The segmentation nucleus, lying free among the yolk granules, is surrounded by a small volume of oöplasm and gives rise to other nuclei by mitosis. Nuclei only are involved in the early cleavages, cell membranes not being present. The cleavages are synchronous among the cells and take place at the rate of one every 10 to 12 minutes at room temperature, 22° to 25° C.

At the 256 cell stage (eighth cleavage) the nuclei begin to migrate to the periphery where cell membranes are formed around them and where they become arranged in a single cellular layer to form the blastoderm (Fig. 1-*B*). At this stage the germ cells are distinguishable by their larger size and location in the posterior polar region. The blastoderm thickens by continued mitosis and growth and presently gastrulation takes place (Fig. 1-C_1). This marks the beginning of somatic differentiation, that is, with respect to the functional activity of the cells. From this point organogenesis proceeds by further differentiation (Fig. 1-, D_1, and E_1).

Biological Activity.—During cleavage and blastulation one of the main functions of the organism is to increase the number of cells (nuclei) present. Since the cleavages are synchronous among the cells the total number is doubled with every division. The significance of such activity will be appreciated when it is remembered that

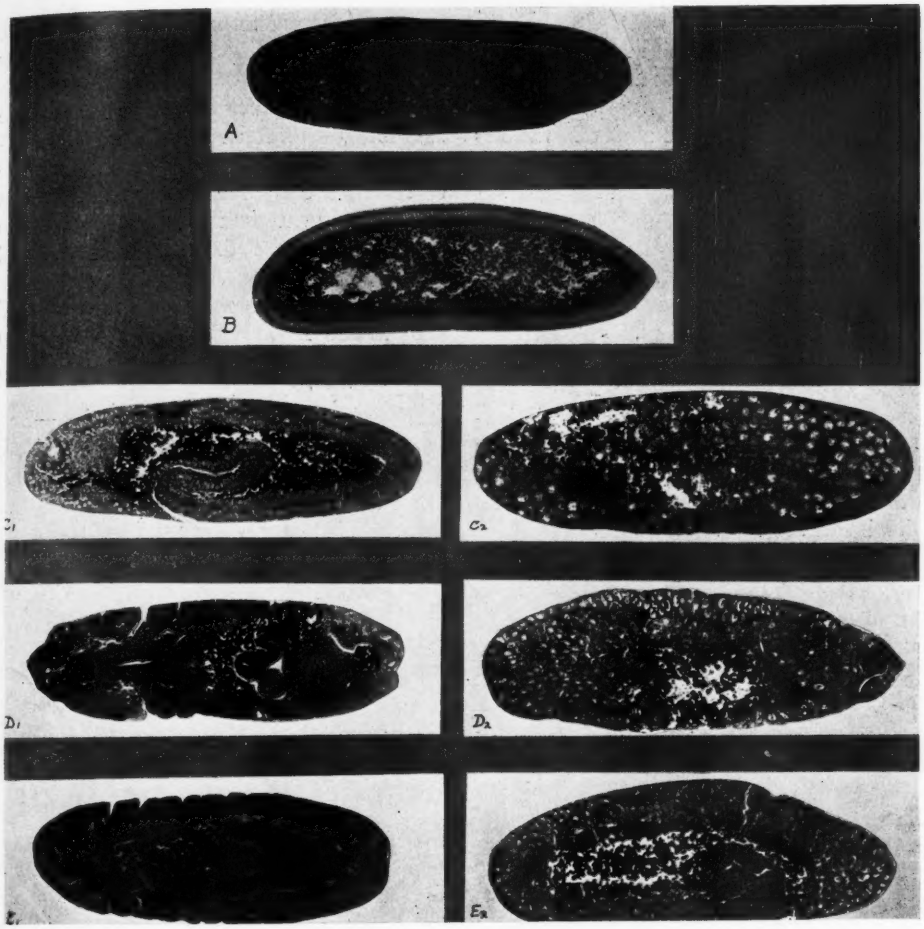

Fig. 1. Sections of *Drosophila* eggs. *A*, *B*, C_1, D_1, and E_1 are of normal eggs at different stages in development. C_2, D_2, and E_2 are of eggs which received a lethal dose of x-rays during the cleavage and blastula stages and fixed from one to two hours after the usual time of gastrulation.

at the ninth cleavage, when the nuclei are moving toward the periphery, 512 cells are present and the next cleavage takes the number to 1,024, the next to more than 2,000, and the next to more than 4,000, etc. Since the cleavages take place at a fairly uniform rate, the rate of increase in the number of cells becomes faster and faster, a process characterized by the so-called *compound interest law*. It may be said, therefore, that the number of cells present increases exponentially with time.[1]

From this it is evident that one of the first steps at the beginning of differentiation[2] (gastrulation) is a slowing of the rate of multiplication of cells. By examining sections of material at different stages of

[1] The fact that a few cells are set aside for yolk and germ cells at an early period prevents the increase from being strictly exponential during the whole time of cleavage and blastulation. This, however, does not modify the fact that a large number of somatic cells is being doubled with every cleavage just before gastrulation, which is the point of importance.

[2] Henceforth in this report the term *differentiation* will apply to somatic differentiation only unless otherwise stated. The few yolk and germ cells which are set aside earlier take little or no part in the development of the soma and, therefore, do not concern us here since the fate of the individuals and not subsequent generations is being considered.

development, it becomes apparent that after gastrulation begins the mitotic activity is localized and confined mainly to growing primordia. Thus in the instances in which several thousand cells are active in mitosis just before gastrulation, only a few are active just after. Depending on how gastrulation is accomplished (by mechanical buckling due to overcrowding of the cells in the blastoderm or by multiplication and growth of localized cells) it is possible that mitotic activity is entirely suspended for a brief period. Indeed it is obvious that the process of doubling the number of cells every few minutes cannot continue indefinitely without soon involving a volume greater than that of the entire egg, that is, unless the cells become smaller and smaller, which is not the case.

Thus, three points may be emphasized. First, that during cleavage and blastulation all of the cells (somatic) are active in mitosis and the rate of increase in number present becomes faster and faster. Second, that coincident with the onset of gastrulation, which is the beginning of differentiation (functional), a very small percentage of the cells present is active in mitosis. Third, that as development proceeds in the various primordia, mitotic activity increases again.

Correlation.—In Figure 2 are shown the changes in susceptibility which take place with age. The curve indicates the amount of radiation required to kill 50 per cent of the eggs in samples of different ages. At the base the stages in development are shown together with certain biologic activity which characterizes the different stages.

It will be seen that during cleavage and blastulation the organisms are relatively very susceptible to the radiation, the resistance increasing several fold at or near the time of gastrulation, and then dropping off again as differentiation gets under way.[3] Hence, since the mitotic activity is highest during cleavage and blastulation, being greatly reduced at the time of gastrulation and higher again after gastrulation, some relation would seem to exist between mitotic activity and radiosensitivity. The correlation, therefore, is an exemplification of the observations made many years ago by Bergonie and Tribondeau (4) in 1906 and numerous times since by others, that the cells which are more active in mitosis and growth are more vulnerable to radiation than those which are not dividing or undergoing growth.

Mitotic Activity after Irradiation.—But, having found a correlation between mitotic activity and radiosensitivity, the question arose as to the significance of this relationship. Why were the organisms more susceptible when the largest number of cells was active and least sensitive when mitotic activity was reduced? Light was shed on these questions by the investigation of one much simpler. Since the eggs were especially sensitive during cleavage and blastulation—the stage when the cells were active in division—how quickly did the cells become inactivated after receiving a lethal dose of radiation? That is, in those eggs which did not hatch, were the cells killed at once by the rays or did they continue to undergo mitosis for some time? Investigation of this disclosed a somewhat unexpected and surprising response.

Sections were prepared of eggs of different ages which had been exposed to lethal doses of radiation during cleavage and blastulation. Examination of these showed not only that the cells continued to divide after treatment but that mitosis seemed to go forward unmolested. Furthermore, organisms which had been fixed from one to two hours after the usual time of gastrulation were found to contain more than the usual number of cells and to manifest little or no differentiation (Fig. 1-C_2, D_2, and E_2). In extreme cases practically the whole interior of the egg was found to

[3] These changes have been described in much greater detail in an earlier report. It may be said in addition here, however, that the same results have been obtained numerous times since and that practically identical results have been obtained by Scott (2) who has studied the changes in radiosensitivity which take place at the different stages of development in the common blue bottle fly, *Calliphora erythrocephila*.

be one solid mass of undifferentiated cells. From this it appears that death in the organisms irradiated during cleavage and blastulation was caused not by restraint of cell growth but by excessive and uncontrolled growth. It would seem that the mechanism, which acts ordinarily to slow the cellular activity and bring about differentiation at the time of gastrulation, must have been damaged by the radiation, thereby permitting cleavage to continue until too many cells were formed and preventing proper differentiation. On the basis of this observation, therefore, it appears that death resulting from irradiation before gastrulation is caused not so much by a direct effect on the cells, *per se*, but by an effect on the factors which normally regulate their activity.

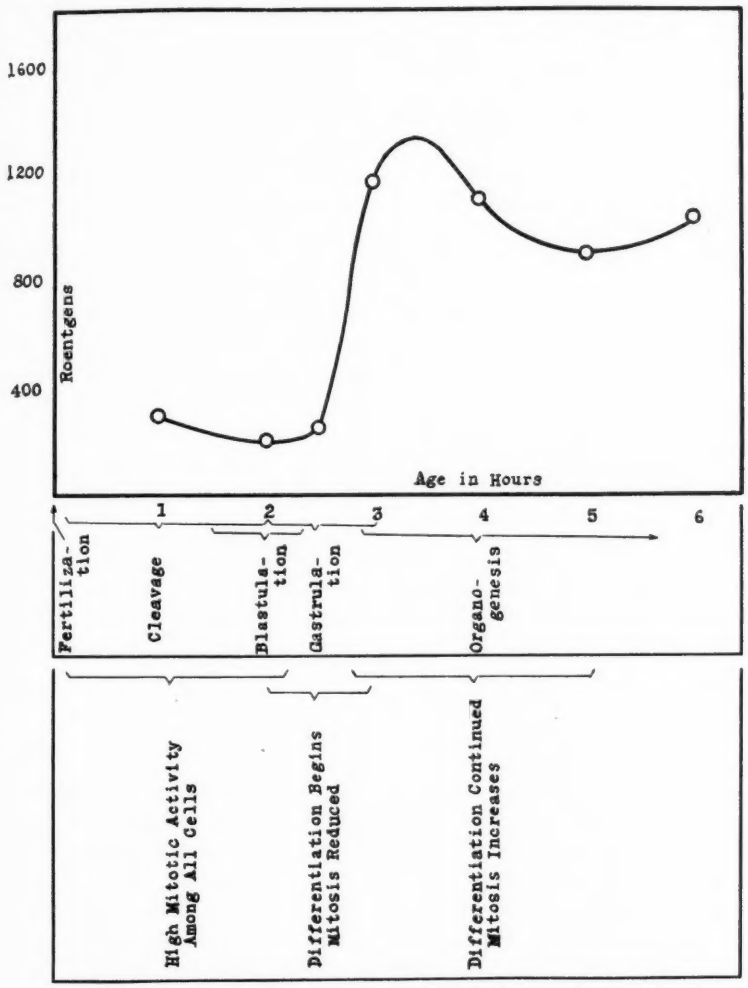

Fig. 2. Curve showing the amount of radiation required to kill 50 per cent of the eggs in samples of *Drosophila* eggs of different ages. The legends beneath correlate age, stage in development, and biological activity with changes in radiosensitivity.

Discussion.—In the foregoing experi-

ments evidence was obtained which indicates that the lethal effect produced by radiation in *Drosophila* eggs is due in some way to modification of the factors which regulate and determine the course of development. With this information an explanation may be offered of why the organisms change so markedly in susceptibility to radiation during development.

Usually when organisms are killed by an external affecting agent, death is attributable to injury produced in the most susceptible vital part. Hence, if the dependence of the organism on such a part should cease to exist, the susceptibility would change and be determined by the next most susceptible vital part and accordingly would be greater. Thus, it may be postulated that some radiosensitive substance, or substances, or the precursor is present during cleavage and blastulation; that this substance is due to exert its influence at the time of gastrulation and bring about slowed mitotic activity and the beginning of differentiation; that having done so it is no longer essential to the organism. In such a case, the radiosensitivity after gastrulation would be determined by the next most susceptible vital part, which in *Drosophila* eggs is considerably more resistant.

These experiments, therefore, serve to direct attention beyond the fact that cells are active or quiescent in accounting for the condition of radiosensitivity. In an earlier report (5) we have determined the relative radiosensitivity of dry and germinated seeds and also of germinated seeds, growing and non-growing. As might have been expected in accordance with the observations of Bergonie and Tribondeau, the dry seeds were found to be more resistant than the germinated ones. However, in case of the germinated seeds quite the opposite was found; the radiosensitivity was the same whether growing or not. These experiments together with those for *Drosophila* eggs above illustrate well the fact that radiosensitivity is determined by the physiologic state or condition of the organism rather than its activity. It would seem that radiosensitivity and growth activity may, in many cases, depend largely upon the same factors. This would account for the fact that susceptibility to radiation and growth activity often appear to go hand-in-hand.

That the factors which regulate differentiation in organisms may be more radiosensitive than the cells which they influence is made evident also by experiments carried out by Butler (6 and 7). Butler amputated the fore limb of *Amblystoma* larvæ and observed the influence of radiation on the regenerating appendage. Ordinarily after amputation a complete new limb is formed containing the usual number of four digits. However, upon exposure to x-rays at the proper stage during regeneration, limbs were produced which had three digits, two digits, one digit, or no digits. Butler points out that the general rules in regard to the effect of radiation on digit formation appear to be as follows: "If the limb is about to enter the two digit condition at the time irradiation is begun, then the first two digits will be formed in a manner apparently normal, but no third digit will ever develop. If the limb is in the two digit condition with the third digit about to appear at the time irradiation is begun, then the third digit will be formed apparently normal, but no fourth digit will ever develop." Butler also states: "The effect of x-radiation on digit formation suggests that x-rays act on differentiating tissue at a certain critical period in the process of differentiation during which there is a heightened sensitivity to x-radiation. If differentiation has passed this critical period before irradiation is begun, then differentiation proceeds even though the animal be irradiated." With respect to differentiation, therefore, Butler's results obtained with *Amblystoma* are very similar to those we have obtained with *Drosophila* eggs in that the factors which initiate differentiation appear to be damaged.

In brief, therefore, evidence has been set forth, which suggests that in some cases at least substances which are normally present in cells to regulate and determine the nature of their physiologic activity are also

important in determining their radiosensitivity.

SUMMARY

1. The radiosensitivity of *Drosophila* eggs at different stages in development has been investigated. It was found that during cleavage and blastulation the organisms were relatively very susceptible and that coincident with the onset of gastrulation the resistance suddenly increases several-fold, dropping off following gastrulation.

2. It was pointed out that during cleavage and blastulation mitosis is synchronous among the cells, divisions taking place at the rate of one every 10 to 12 minutes. Further, that gastrulation marks the beginning of differentiation (somatic) and is accompanied by a reduction of mitotic activity. The latter demonstrates the influence of important factors which regulate developmental processes.

3. Prepared sections of material, which had been given lethal doses of radiation during the most susceptible stages (cleavage and blastulation) and fixed at different times after gastrulation ordinarily takes place, showed the following: (1) that mitosis goes forward apparently unmolested after irradiation; (2) that little or no differentiation takes place, and (3) that death is probably caused by unrestrained growth and lack of differentiation of the cells.

4. From this it is evident that one of the most important effects of radiation at this stage is a modification of the factors which regulate and control the nature of cellular activity. Accordingly, the results indicate that such regulators of activity are important, in certain cases, in determining radiosensitivity.

The writer wishes to express his indebtedness to Dr. G. Failla for interest and helpful suggestions throughout the course of the work.

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PULMONARY METASTASIS: A PATHOLOGIC, CLINICAL, ROENTGENOLOGIC STUDY BASED ON 78 CASES SEEN AT NECROPSY[1]

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From the X-ray Department of the Jefferson Medical College Hospital

IN THE ten-year period from November, 1924, to November, 1934, pulmonary metastasis was found in 78 patients coming to autopsy at the Jefferson Hospital. Many of the patients had had roentgenograms of the chest made prior to death; this study is based on the x-ray findings, the necropsy protocols, and the clinical histories. Most of the necropsies were performed by Dr. Baxter L. Crawford, Pathologist to the hospital, or his assistant, Dr. Carl J. Bucher, though some were performed by other members of the staff.

Type of Primary Tumor.—Sixty-one, or 78 per cent, of the primary tumors were classified as carcinoma; 12, or 15.3 per cent, as sarcoma; two, or 2.4 per cent, as melanoma; one as an endothelioma; one as a teratoma, and one as a thymic tumor (Table I).

TABLE I.—TYPE OF PRIMARY TUMOR

	No.	Percentage
Carcinoma	61	78.2
Sarcoma	12	15.3
Endothelioma (pleura)	1	1.2
Teratoma (testicle)	1	1.2
Melanoma (skin)	2	2.4
Thymic tumor	1	1.2
	78	

Site of the Primary Tumor.—The site of the primary tumor was determinable in all but five instances; the 56 carcinomas in which it was determined may be classified under six systems (Table II). The breast was the primary site in seven, or 11.4 per cent of the cases; the ductless glands in four, or 6.5 per cent; the generative organs in eight, or 13 per cent; the respiratory

TABLE II.—ORIGIN OF PRIMARY GROWTH: 61 CASES OF METASTATIC CANCER

	No.	Percentage			No.	Lungs only
Breast	7	11.4				1
Ductless glands	4	6.5		Adrenal	3	1
				Thyroid	1	
Gastro-intestinal	21	34.4		Duodenum	1	1
				Esophagus	3	
				Liver	3	1
				Pancreas	5	
				Pharynx	2	
				Stomach	7	
Generative	8	13	Female 1	Ovary	1	
			Male 7	Prostate	6	2
				Testicle	1	
Respiratory	7	11.4		Bronchus	1	
				Larynx	3	
				Lung	3	
Urinary	9	14.7		Bladder	2	
				Kidney	7	2
Undetermined	5	8.1		Generalized	4	1
				Necropsy limited	1	
	61					9

[1] Presented before the Radiological Society of North America, at Memphis, Tenn., Dec. 3–7, 1934.

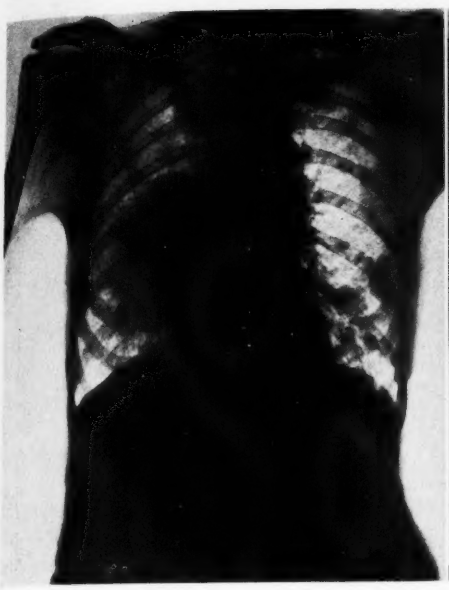

Fig. 1

Fig. 2.

Fig. 1. Metastasis from carcinoma of the breast. Numerous, well-defined, dense deposits can be seen throughout the left lung, with a large mass at the right hilum. (G. T., female, 63 years; from the service of Dr. Thomas A. Shallow.)

Fig. 2. Metastasis from adenocarcinoma of the adrenal. Numerous, sharply circumscribed masses can be seen throughout both lungs. (E. L., female, 27 years; a patient of Dr. Elmer H. Funk and Dr. Reynold S. Griffith.) At necropsy, Dr. Baxter L. Crawford found many sharply described nodules scattered throughout both lungs.

tract in seven, or 11.4 per cent, and the urinary organs in nine, or 14.7 per cent. In four cases it was impossible to determine the primary site, and in one the necropsy was limited to the thorax.

The large number arising from the gastro-intestinal tract (21, or 34.4 per cent) is of interest, and it should be noted that none had origin distal to the duodenum. In spite of the fact that the large intestines, notably the rectum, sigmoid, and descending colon are frequently the site of primary malignant disease, none of the cases in this series were from tumors arising at these sites.

One-third, or 7 per cent, of the metastasizing carcinomas of the gastro-intestinal tract had their origin in the stomach. Three were classified as adenocarcinoma, one as colloid, and one as anaplastic; in the other two the histologic structure was not specified.

The widely recognized high incidence of pulmonary metastasis from malignancy of the prostate is confirmed in this study. Of the seven cancers arising in the male generative organs, six arose in the prostate.

Analysis of the sarcomas is not so informative because of the small number of cases. The 12 sarcomas were classified according to origin as arising in the frontal sinus, neck, chest-wall, thigh, leg, lung, pleura, spleen, or uterus. According to the histologic type, they were classified as round-cell, spindle-cell, mixed-cell, lymphosarcoma, metastatic melanotic sarcoma, myosarcoma of the uterus, and sarcomatosis.

Extent of Metastasis.—In nine, or 14.7 per cent, of the carcinomas, metastasis was limited to the lungs. Coupling the two cases of prostatic cancer with the two of renal cancer indicates that 44.4 per cent of the cancers in this series, which metasta-

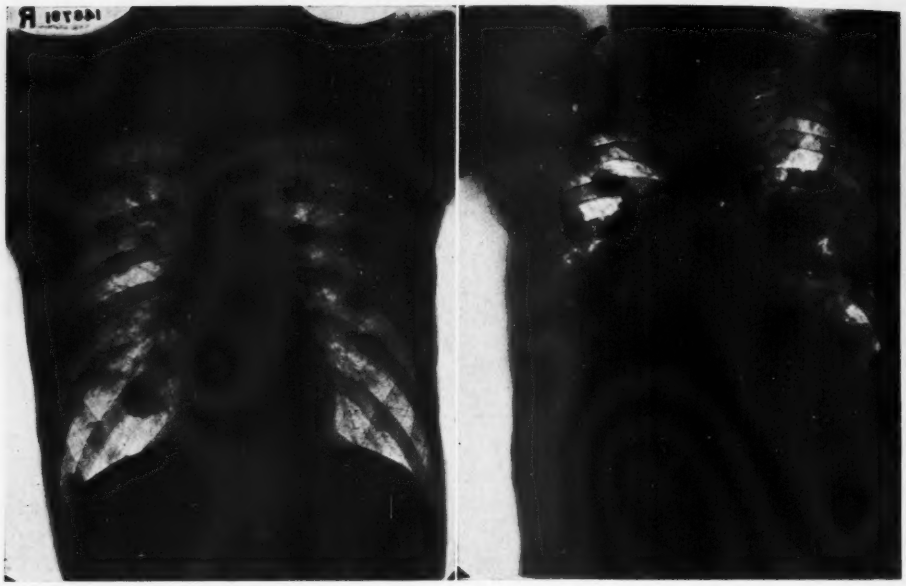

Fig. 3. Fig. 4.

Fig. 3. Metastasis from melanotic sarcoma—primary—on sole of foot. Well-defined, dense nodules can be seen throughout both lungs. (J. D., male, 35 years; from the service of Dr. Edward J. Klopp.)
Fig. 4. Metastasis from adenocarcinoma of the pharynx. Large, dense nodules are scattered throughout both lungs; more numerous in bases. (W. S., male, 50 years; from the service of Dr. Micheal J. Burns.)

sized only to the lungs, had their origin in the genito-urinary organs.

Metastasis was confined to the lungs in three, or 25 per cent, of the sarcomas. In the sarcoma of the frontal sinus, the mixed-cell sarcoma of the leg, and the round-cell sarcoma of the thigh, the lungs were the only organs in which metastasis was found at necropsy.

When metastasis was not limited to the lungs, its spread might have been almost local and confined to the regional lymph nodes or it might have been widely disseminated. In one or more cases, pulmonary metastasis was accompanied by metastasis to the pleura, liver, pancreas, intestines, omentum, adrenal gland, spleen, bladder, kidney, testicle, heart, pericardium, breast, brain, dura, skin, subcutaneous structures, or skeletal muscles.

Gross Pathologic Appearance.—The typical lesion of pulmonary metastasis is the nodule. When unaccompanied by local secondary changes or by pleural changes the descriptions of the nodules are similar to those employed by the roentgenologist in describing their shadows.

In most instances the gross nodules are firm and sharply circumscribed, though they may be hard or soft. They are usually multiple and are described as being scattered throughout the lung, or the lung is said to be studded with them. Sometimes they are single, and frequently they are described as being subpleural or limited to a few centimeters beneath the pleura.

The size of the nodules varies from those described as miliary to those which are several centimeters in diameter. Between the two limits they are frequently described as "pin-head" or "match-head" in size.

The terms "shot-like," "scattered," "innumerable," "spherical," "circumscribed," "pin-head," "match-head," recur time after time in the protocols, and should be borne in mind because they are also de-

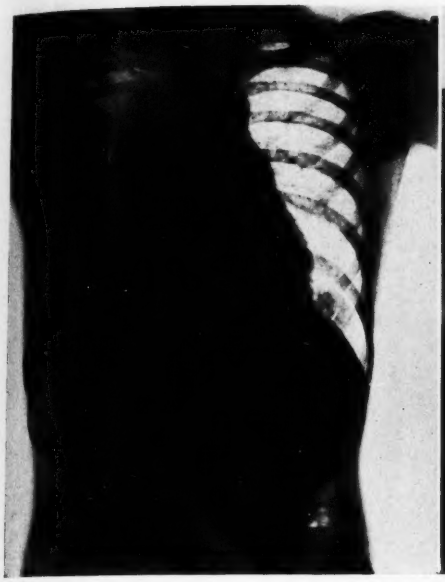

Fig. 5.

Fig. 6.

Fig. 5. Metastasis from tumor of undetermined origin. Massive densities can be seen at the right root area, and throughout the right lung; one smaller mass is seen close to the left cardio-phrenic angle. (L. S., male, 15 years; from the service of Dr. Edward J. Klopp.) A biopsy from the tumor in the right shoulder was difficult to classify, while clinically it seemed to be primary. Dr. Baxter L. Crawford found it metastatic also.

Fig. 6. Metastasis from adenocarcinoma of the endometrium. The left lung is evenly dense—on the original film sharply defined masses could be made out in that area. The heart is displaced to the left, and the left half of the diaphragm is elevated. A few, not very dense, masses in the right lung can be seen. (M. G. N., female, 54 years; a patient of Dr. Brooke M. Anspach.)

scriptive of the lesions as seen roentgenographically (Figs. 1 and 2).

The typical appearance is altered when bronchial occlusion occurs, or when massive changes take place in the pleura (Fig. 5). Occlusion of the bronchus may be due to extension of a nodule into the lumen (Figs. 5 and 9), or to compression of the bronchus by nodes at the hilum. Occlusion of the bronchus by metastasis to the wall is uncommon; the instance illustrated by Figure 9 was secondary to a melanoma. With occlusion of the bronchus, the lung collapses and at necropsy is found to be firm, solid, and airless.

Pleural metastasis accompanying pulmonary metastasis frequently leads to the development of fluid, with compression of the lung (Fig. 7). Occasionally, when metastasis is secondary to invasion of the bronchial wall by the extension of metastatic changes from the nodes at the hilum, the lesion is described as infiltrative. However, this is an unusual form.

Clinical Features.—Sex: of the 78 patients, 53 (or 67.9 per cent) were males, and 25 (or 22.1 per cent) were females (Table III).

Age: the decades from 40 to 60 years showed the highest incidence; 42 (or 53.8 per cent) of all patients were in these age groups. The seventh decade had the next highest incidence, 10 (or 12.8 per cent) being in this group (Table III).

Symptoms.—Local symptoms due to pulmonary metastasis are few, and are determined by the extent and character of the changes; more than half the patients had no local respiratory symptoms. In 37 histories it was recorded that there were no respiratory symptoms; in six others no mention was made of respiratory symp-

Fig. 7.

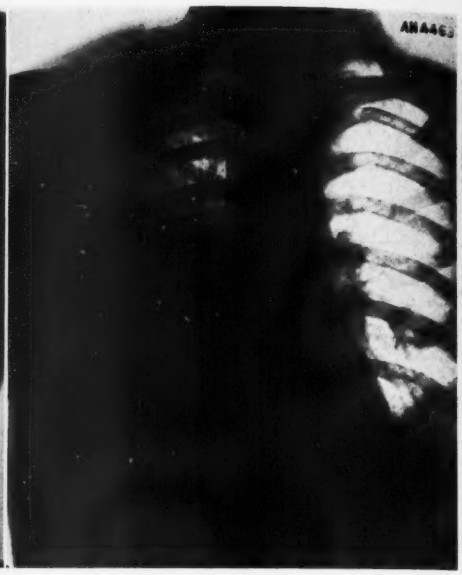

Fig. 8.

Fig. 7. Adenocarcinoma of the anaplastic type of the right lung. The right half of the chest is evenly dense, due to fluid and tumor; left lung is grossly normal. (B. N., female, 52 years; a patient of Dr. S. Dale Spotts.) At necropsy, a tumor of the right lung was found by Dr. Baxter L. Crawford, with the lung greatly compressed by fluid in the pleural cavity, and numerous miliary nodules were scattered throughout the left lung.

Fig. 8. Metastasis from carcinoma of undetermined origin. Markings throughout the right lung are increased and there is a slight increase in the markings at the left costophrenic angle; changes resemble those of an inflammatory process. (D. C., male, 23 years; a patient of Dr. Louis H. Clerf.) At necropsy, by Dr. Baxter L. Crawford, done six days after this roentgenogram was made, 2,000 c.c. of fluid were removed from the right pleural cavity, and numerous metastatic nodules were found throughout both lungs.

TABLE III.—SEX-AGE DISTRIBUTION

	No.		Percentage
Males	53		67.9
Females	25		32.1
Years			
1–10	1		1.2
21–30	6		7.6
31–40	11		14.1
41–50	21	53.8	26.9
51–60	21		26.9
61–70	10		12.8
71–80	7		8.9
81–90	1		1.2

TABLE IV.—SYMPTOMS

	No.	
Dyspnea	23	
Cough	15	
Pain	9	
Expectoration	6	
Hemoptysis	2	
Hoarseness	1	
None	37	55.1%
Not recorded	6	

TABLE V.—DURATION OF LIFE

	No.	Percentage
1–6 months	35	44.8
6–12 months	16	20.5
12–18 months	8	10.2
18–24 months	2	2.5
Over 24 months	7	8.9
Unknown	10	12.8

toms though other symptoms were listed so that 43, or 55.1 per cent, of the patients had no symptoms referable to the respiratory tract (Table IV).

Dyspnea was the most frequently encountered symptom; it was recorded in 23 histories. Fifteen patients complained of cough, nine of pain in the chest, six of expectoration, two of hemoptysis, and one of hoarseness. The low incidence of hemoptysis in metastasis is in marked contrast to its high frequency in primary pulmonary neoplasm. Pain in the chest and

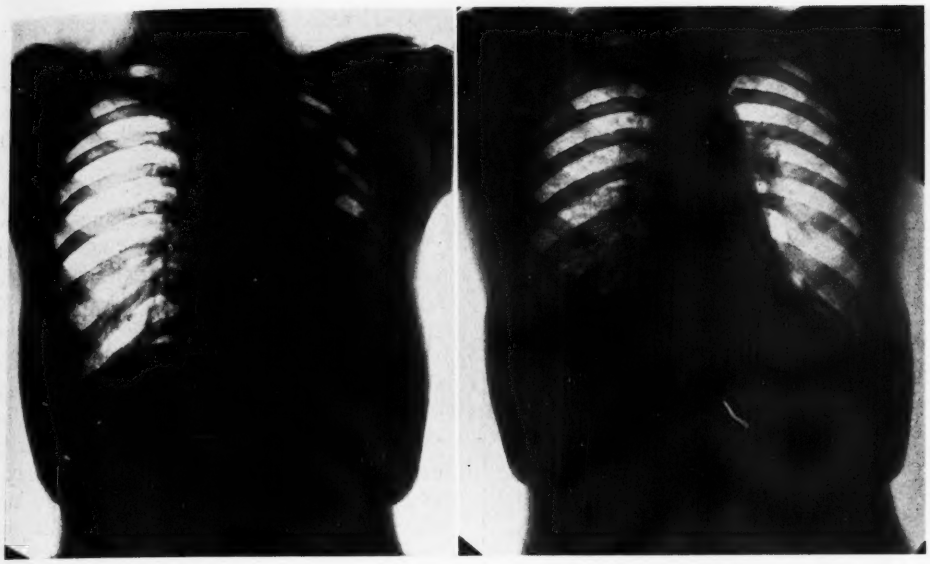

Fig. 9-*A*. Fig. 9-*B*.

Fig. 9-*A*. Metastasis to the bronchial wall, from recurrent melanoma of the skin. The lower portion of the left lung is dense; the left half of the diaphragm is elevated, and the heart is displaced to the left, due to atelectasis from occlusion of the left lower lobe bronchus by a metastatic mass in the wall. (F. F., female, 32 years; a patient of Dr. Louis H. Clerf.) She complained of a dry, hacking cough and dyspnea. Eighteen months prior to admission, a mole on her arm had been "treated with an electric needle." The wound failed to heal, and six months later the area was excised, with subsequent healing. At bronchoscopy, Dr. Clerf removed a piece of tissue which was diagnosed as metastatic melanoma by Dr. Baxter L. Crawford (cf. Fig. 9-*B*).

Fig. 9-*B*. Same patient as in Figure 9-*A*. There was a re-expansion of the left lung after bronchoscopic removal of a metastatic nodule from the left bronchus. The left lung is really over-distended, due to the ball-valve action of the residue of the metastatic nodule still producing partial occlusion. At necropsy, 18 months after admission, Dr. Crawford found several small pigmented nodules in both lungs.

expectoration also occur much more frequently in primary newgrowth. Pain occurred usually when there were massive pulmonary changes or when the pulmonary metastases were accompanied by pleural metastasis.

Duration of Life.—Duration of life following the discovery of the primary tumor was determined from the history (Table V). It was possible to estimate it in 68 instances: in 10 patients, duration could not be determined with any degree of accuracy. Patients with tumors which metastasize to the lungs do not, as a rule, survive long. In this series, 35 (or 44.8 per cent) of the patients died within six months of the discovery of the primary tumor; 16 (or 20.5 per cent) survived from six months to one year; eight (or 10.2 per cent) from 12 to 18 months, and two (or 2.5 per cent) from 18 months to two years. Of the entire group, only seven (or 8.9 per cent) were known to have survived the primary tumor for more than two years.

Roentgenographic Appearance.—As the nodule is the gross morbid anatomic evidence of pulmonary metastasis, so is the shadow of the nodule typical of metastasis. The shadow of the typical pulmonary metastatic nodule appears on the roentgenogram as a round or almost round, sharply margined area of density. Usually the shadows are multiple, for in most instances the "innumerable" "spherical" "circumscribed" nodules found at necropsy are scattered throughout the entire lung or in both lungs (Figs. 1, 2, 3, and 4). Sometimes they are less numerous, and occasionally there are but one or two masses (Fig. 5). The size of the areas of

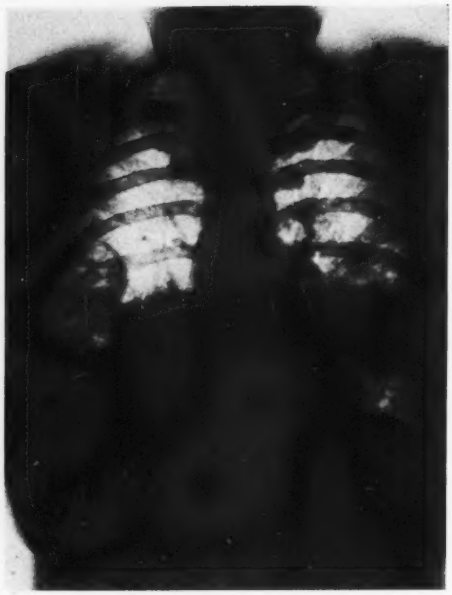

Fig. 10. Metastasis from sarcoma of undetermined origin. There may be seen large sharply circumscribed annular cavities, with fluid levels in the lower half of the right chest, and nodules in the left lung. (L. A., female, 41 years; a patient of Dr. Louis H. Clerf and Dr. Samuel A. Loewenberg.) The patient had a cough, with expectoration of mucus, of many years' duration. At necropsy, Dr. Herbert Lund found numerous nodules throughout both lungs, some with soft centers, others containing blood; one in the right lower lobe communicated with a bronchus. The origin of the primary growth could not be determined.

density vary from a match-head to several centimeters. When innumerable, the nodules are apt to be smaller than when only a few are present.

The density of the shadow varies. When due to dense deposits, the shadows are very distinct, their densities in some instances approaching that of the heart (Fig. 4); in other cases the nodules are less solid and the shadows fainter. The shadows may be scattered over both pulmonary fields or confined to one or to a part of one field.

Pleural complications and collapse of the lung due to bronchial occlusion or compression from pleural exudate alter the appearance (Fig. 6). In some instances the nodules may be entirely lost in the shadow of the effusion.

Metastatic pulmonary disease is sometimes mistaken for congestive or inflammatory changes, dust changes, tubercle formation, or multiple suppurative foci. Increase in the markings described as due to congestion or to dust changes are seen when the lesion is of the type which at necropsy is described as due to miliary deposits. These changes are so nebulous that at necropsy it is sometimes difficult from the gross appearance to be sure of their exact nature.

Metastasis is mistaken for tuberculosis when the deposits vary in size and are not sharply defined. Sometimes changes in the opposite pulmonary field, due either to collapse of a lung or a part of it or to pleural exudate, mislead the observer. The history of the patient, together with the known existence of a primary tumor, may sometimes assist in reaching the proper diagnosis.

Multiple metastatic lesions rarely break down; when they do they may be mistaken for cystic disease. The multiple cavities and fluid levels seen in the sarcomatous metastasis in Figure 10 are extremely rare. Metastasis to the bronchus may produce atelectasis, as in Figures 6 and 9. In these instances, as in those cases with massive pleural changes, it may be impossible to do more than determine the character of the structural changes without being able to determine that the occluding mass is metastatic. In some instances the presence of typical metastatic nodules in the opposite lung makes the diagnosis clear.

SUMMARY

1. In 78 cases of pulmonary metastasis seen at necropsy, 61 (or 78.2 per cent) of the primary tumors were carcinomas; 12 (or 15.3 per cent) were sarcomas; two (or 2.4 per cent) were melanomas, and there was one each of teratoma, endothelioma, and thymic tumor.

2. In 73 tumors, the site of the primary tumor was found to be in one of 17 organs; in five instances the primary site could not be determined.

3. In 66, or 84.4 per cent, of the entire

series of cases, pulmonary metastasis was accompanied by metastasis to other organs. In 9, or 14.7 per cent, of the carcinomas and in 3, or 25 per cent, of the sarcomas, metastasis was limited to the lungs.

4. The typical lesion of pulmonary metastasis is the nodule. It varies in size, distribution, and density. Changes due to bronchial occlusion or to pleural effusion may hide the nodule and produce other metastatic changes described as collapse or solidification of the lung.

5. Of the patients, 53, or 67.9 per cent, were males; 25, or 22.1 per cent, were females.

6. The highest incidence of metastasis occurred in the decades from 40 to 60 years—42, or 53.8 per cent, of the patients were in this age group.

7. Local respiratory symptoms are not a prominent feature of pulmonary metastasis; 43, or 55.1 per cent, of the patients had no respiratory symptoms. Dyspnea and cough are the symptoms most frequently encountered. In contrast to primary pulmonary neoplasm hemoptysis is rare and expectoration infrequent.

8. Thirty-five, or 44.8 per cent, of the patients died within six months of the discovery of the primary tumor; only 7, or 8.9 per cent, were known to have survived more than two years after the discovery of the primary growth.

9. The shadow of the nodule is the typical roentgen sign of pulmonary metastasis. It is usually a sharply defined round shadow, varying in size, density, and distribution. While usually multiple, it is sometimes single or there may be only a few present. It may be obscured by pleural changes or collapse of the lung. Metastasis must be differentiated from the changes of congestion, inflammation, dust invasion, and tubercle formation.

THE DIAGNOSIS OF PRIMARY CARCINOMA OF THE LUNG[1]

By C. H. HEACOCK, M.D., *and* J. CASH KING, M.D., *Memphis, Tenn.*

A VOLUMINOUS literature has accumulated regarding primary carcinoma of the lung. A great deal concerns the increased incidence of the disease; a relatively small amount concerns the diagnosis and treatment. However, many excellent articles have appeared regarding the diagnosis, the improved surgical procedures, and roentgen-ray therapy in malignant diseases of the chest. The American Society of Thoracic Surgeons has established a registry for lung tumors, which has stimulated interest and made possible more definite diagnoses based upon pathologic studies. It has only been since a large number of cases have been subjected to roentgen-ray and bronchoscopic examinations that the advance in accuracy of diagnosis has been appreciable.

Junghanns (8) gives an interesting table of clinical diagnoses based on 152 cases of carcinoma of the lung. They were tabulated according to five-year periods, from 1908 to 1929. In the early cases of this series, 10 per cent had a positive clinical diagnosis, whereas in the last group 48 per cent of the clinical diagnoses were correct. Since the greater progress was made between 1908 and 1929 in the special methods of examination, as roentgenologic and bronchoscopic, it seems reasonable to conclude that these agencies were responsible for the increased accuracy in diagnosis. Little has been contributed to the symptomatology and ordinary methods of physical examination during that time.

As a rule, the history is not a dependable guide. The onset of symptoms may be abrupt or gradual; coughing and expectoration may indicate merely bronchial irritation. In carcinoma, pain usually occurs early and is severe. Dyspnea is always present, and hemoptysis is fairly common. The physical signs also are varied, but often the entrance of air into one or more lobes is limited. Probably the most important fact of all to remember is that the signs occur on only one side. The routine laboratory procedures, as blood studies, urinalyses, and sputum examinations, are seldom of value. When pleural effusion is present, a study of the aspirated fluid may give additional information. Blood-stained fluid, found in about half the cases, is suggestive.

Of the two methods of special examination, the bronchoscopic has definite advantages over the roentgenologic. It permits direct visualization of about 85 per cent of all the lesions—those occurring in the primary and secondary bronchi. Further, the operator may secure a biopsy specimen for histologic study. In early cases, as has been reported by Jackson (7), complete removal may be effected at the time the diagnostic study is made. The high degree of operative skill necessary for this procedure constitutes the chief limitation to its use. Highly skilled bronchoscopists are found in a few of the larger medical centers only, and probably those who can safely and successfully explore the tertiary bronchi are found only in a small number of world-famed clinics. It seems true to us that in the smaller cities the plane of radiology is higher than that of bronchoscopy. Because of their availability, roentgenologists see these patients first, and they must be able to recognize the possibility of a new-growth to determine whether or not many of them will ever reach a bronchoscopist. A large percentage of cases may be diagnosed from the roentgenograms alone, but many others will present findings which should suggest a bronchoscopic study.

Roentgenologic Diagnosis.—Rist and Rolland (12) observe six different radiologic appearances of carcinoma of the lung; Carman (2) followed Arnsperger, Jaugeas,

[1] Presented before the Radiological Society of North America, at Memphis, Tenn., Dec. 3–7, 1934.

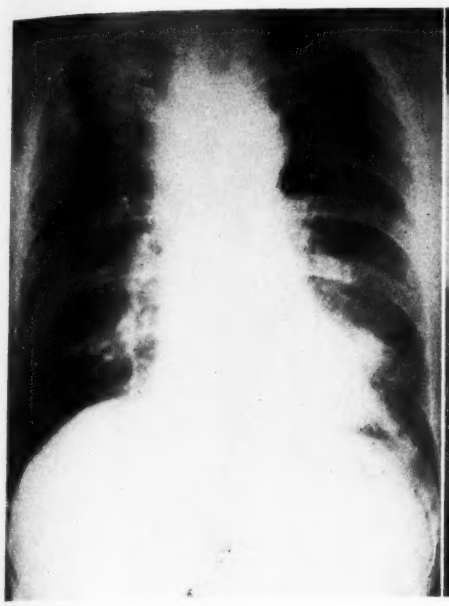

Fig. 1.

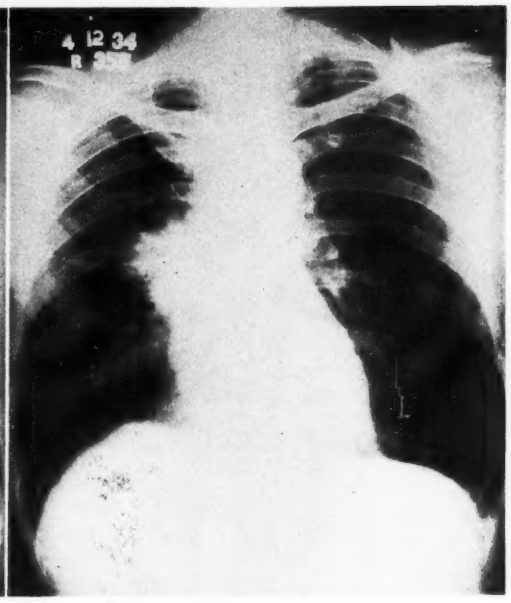

Fig. 2.

Fig. 1. Case 2 (see table). Only a small shadow can be seen at the left cardiac border on the usual postero-anterior view of the chest. The tumor could be well demonstrated fluoroscopically (see text). At autopsy, six months later, the tumor occupied the entire left lower lobe—parenchymal type.

Fig. 2. Case 11 (see table). Infiltrative type of bronchial carcinoma. No improvement following one protracted course of roentgen therapy. Patient died five months following this examination.

Barjohn, and Otten in recognizing two main types. More recently, Kirklin, Paterson, and Vinson (11) and Farrell (6) have adopted the same classification with respect to the location of the primary shadows, namely, whether they are hilar or lobar. Kirklin and Paterson (10) also list a third group—when the condition is advanced and late and it is no longer possible to determine how or where the tumor may have had its origin.

During the early stage of bronchogenic carcinoma, while all the neoplastic tissue is endobronchial, the roentgenogram will be practically negative. Carman cited such a case and gave an illustration of the pathologic specimen. Distant metastases were present while the primary growth was still a small endobronchial plaque, found with difficulty only at necropsy.

Even in the very early cases it is probable that there will be some interference with the passage of air and some obstructive emphysema. This will be overlooked unless it is specifically kept in mind during the fluoroscopic examination. Films made at the end of inspiration and expiration should also be studied. In the absence of a history of the aspiration of a foreign body such an examination is seldom made and so this earliest of signs is overlooked. No reference to the use of this method in diagnosis was found in the literature. A definite diagnosis cannot be made, but the findings should be sufficient to determine the necessity for a bronchoscopy.

Practically all bronchogenic carcinomas, however, soon reach a peribronchial stage and acquire a size sufficient to cast a shadow on the roentgenogram. Typically, this type of newgrowth occurs near the hilus and extends toward the periphery of the lung-field. It may assume the character of the so-called infiltrative type, with fringy, irregular borders that appear to give off ramifications in all directions,

especially toward the periphery of the lung field. On the contrary, the borders may be circumscribed with fair sharpness.

Fig. 3. Case 19 (see table). Circumscribed type of bronchial carcinoma. The borders of the tumor could not be determined until a film was made with the Bucky diaphragm, with sufficient density to differentiate between the tumor and the atelectasis.

Since these growths are both intralumenal and extralumenal, it is necessary to understand the mechanism of bronchial obstruction. This has been well described by Jackson, who recognizes the following three mechanical types: first, stop-valve obstruction, in which no air can get in or out; second, by-pass valve obstruction, in which the lumen is simply narrowed, and third, check-valve obstruction, permitting the flow of air in one direction only, and causing either an obstructive atelectasis or an obstructive emphysema. In cases of stop-valve obstruction, the air distal to the obstruction is soon absorbed and we have an atelectasis of the lung supplied by that bronchus. By-pass valve obstruction is rarely encountered, as these growths so soon pass into the stage of stop-valve obstruction. In the early stages, malignant growths may produce a check-valve effect. At one time the growth may function so as to permit the entrance of air, causing an obstructive emphysema; at another time, it may prevent the entrance

Fig. 4-*A*. Case 4 (see table). Primary carcinoma of the right hilus with atelectasis and pleural effusion. Infiltrative type of metastasis of the left hilus. Case proven by autopsy.

Fig. 4-*B*. Same case as shown in Figure 4-*A*. Examination made six weeks later and after the aspiration of bloody fluid, which permits the visualization of the tumor mass and the atelectasis.

of air, so that an atelectasis develops. In such cases we have an alternating emphysema and atelectasis: one of our patients demonstrated this phenomenon. All cases eventually manifest a stop-valve effect, with resulting atelectasis. After a lapse of a variable period of time, drowned lung follows, the defensive powers of the lung are destroyed, and the ventilation and drainage are cut off. Since organisms are always present, infection quickly develops, and we have, successively, bronchiectasis and abscess formation, and frequently gangrene. At this late stage the growth can no longer be recognized as a bronchogenic carcinoma. Even before we see all the manifestations of infection, however, pleural irritation may give rise to an effusion which will completely overshadow the original tumor.

Pulmonary newgrowths, arising in the parenchyma of the lung, probably do not represent more than 15 per cent of all malignant primary growths. In Kirklin's series, however, there were 23 bronchogenic and 22 parenchymal types. The parenchymal type starts as a nodule, which gradually increases in size until it involves the entire lobe. Its density is always more or less homogeneous, and its distinctive feature is its confinement by the interlobar pleura. The margins may be fringy or fairly circumscribed. When the right upper lobe is involved, the lower border of the density assumes an S-shaped curve, as Sante (13) has pointed out. Bronchial obstruction is not so likely to complicate the picture of a parenchymal tumor, but central necrosis may occur and produce a so-called cavernous carcinoma, described by Kerley (9). The squamous-cell carcinomas are parenchymal. Of 93 cases studied at autopsy by Atkins (1), those with definite cavitation were of the squamous-cell type. By direct extension to the pleura, these tumors may also cause pleural effusion.

The abstracts of 25 case histories are tabulated. In 13 of these, the diagnosis was based upon a pathologic foundation. Seven of the 13 patients came to autopsy, one had a surgical operation, and two had

Case	Symptoms	Physical signs	X-ray findings	Pathologic report	Remarks
No. 1. H. W. L. male, age 57 years	Onset with cough one year previously. Some loss of weight. Pain over left chest, with some dyspnea	Emaciated. Edema of both sides of neck. Decreased breath sounds over upper left lobe	On Jan. 30, 1933, there was an area of increased density on left side, projecting from cardiac border. Margins very irregular. All peritruncal shadows exaggerated	Gland removed from side of neck showed malignancy. Autopsy revealed a primary carcinoma of left lower bronchus. Metastases to cervical and mediastinal glands.	Extreme emaciation and rapid death
No. 2. H. B. H., male, age 72 years	Onset five weeks previously, with repeated hemoptysis. Pain in left costal region of two months' duration. No dyspnea. Some loss of weight and anorexia	Emaciated. Sticky râles at angle of left scapula	On Feb. 10, 1932, fluoroscopy and stereoroentgenograms revealed a small area of consolidation posterior to heart, the size of a small orange. Diagnosis, based on x-ray and history, was primary carcinoma of the lung	Died on Aug. 29, 1932. Autopsy revealed primary carcinoma of left lower lobe, with metastases to both lungs, hilar lobes, and brain	No bronchoscopy. Diagnosis was made early from fluoroscopy
No. 3. W. F., male, age 51 years	Onset six months previously, with cough and blood-streaked sputum. Lost 25 pounds weight in six months. Fever and sweats of two months' duration. Slight, increasing dyspnea	Emaciated. Dullness in right apex. Decreased expansion. Bronchovesicular breathing and râles in same area. Sputum negative for tubercle bacilli	On Jan. 2, 1930, there was an opacity of entire right upper lobe, with an area of decreased density near the hilus. Reported as an abscess	Died a few months later. Autopsy showed a carcinoma of right upper lobe, with abscess and gangrene	Patient improved after x-ray therapy
No. 4. Male, age 28 years (682)	Cough and pain in right chest for three months. Expectoration with no blood. Fever on one occasion.	Dullness in right apex. Flatness at right base	Sept. 8, 1932—primary carcinoma of right hilus. Atelectasis of right, middle, and lower lobes. Infiltrative metastases of left lung Oct. 17, 1934—opaque mass in the right hilus. Atelectasis of right middle and portion of right lower lobes. Metastases were extended	Died a few months later. Autopsy showed a carcinoma right primary broncus metastatis to left lung	Bloody fluid was aspirated (180 c.c.)
No. 5. Female, age 62 years (218)	Cough, dyspnea, and pleuritic pain in left side	No record	(1) Uniform, dense, circumscribed shadow of left hilus. (2) Shadow increasing in size; some distal atelectasis	Carcinoma of left upper bronchus, extending into lobe and blocking bronchus. Areas of necrosis. Metastasis to right lung and to cervical glands	
No. 6 Male, age 49 years (21147)	Duration two years; 50 pounds loss of weight. Severe cough and dyspnea; hemoptysis	Emaciation. Signs of consolidation of upper right lobe	March 17, 1931—shadow in right upper hilus; not circumscribed. Trachea pulled over March 24, 1931—now atelectasis almost entire right lung	Autopsy revealed a mass (primary carcinoma) obstructing right upper bronchus. Atelectasis of right upper and middle lobes; bronchiectasis. Metastases to liver, kidney, and thyroid	

Case	Symptoms	Physical signs	X-ray findings	Pathologic report	Remarks
No. 7. Male, age 63 years (21191)	History of cough and dyspnea of three months' duration	Emaciation. Signs of consolidation of right upper lobe	Consolidation of entire right upper lobe. Homogeneous density. Lower border has "S" curve	Autopsy revealed cancer of lung. Tumor mass involving entire right upper lobe. Central area of necrosis. Metastases to right lower lobes, liver, and kidney	
No. 8. T. D. F., male, age 30 years	Onset two weeks previously, with cough and dyspnea. Weight loss marked during stay in hospital	Dullness over right lobe from third to sixth ribs anteriorly. Breath sounds decreasing over same area. Sputum negative for tubercle bacilli. No lesions seen on bronchoscopy	Nov. 30, 1932—hydropneumothorax on right side. Jan. 30, 1933—small hydropneumothorax persists. Entire lung consolidated, with variations in density suggesting multiple small abscesses. Left lung clear	Surgical diagnosis: inoperable cancer of lung	Died. There was never any involvement of the other lung
No. 9. Male, age 46 years (1974)	Productive cough for several months. Loss of weight. No hemoptysis	Clubbed fingers for eight months. Emaciated. No evidence of tumor in the bronchus	Circumscribed area of increased density (6 × 6 cm.) anteriorly at left costophrenic angle. Diaphragm adherent to mass. Lipiodol injection shows abrupt termination of bronchi at borders of tumor	Metastatic mass removed from posterior thigh and femur; reported adenocarcinoma	X-ray treatment gave relief from pain but no regression in size of tumor. On July 3, 1934, bronchoscopy was negative. Patient increasingly weaker. Edema of feet and legs
No. 10. Male, age 56 years (24915)	Dyspnea 4 plus, with pain, cough, hemoptysis. Duration, six weeks	No loss of weight. Right chest flat. Right base flat. Supraclavicular glands enlarged	Shadow occupying right apex above second interspace. Solid tumor. Fluid in right side to third interspace. Small amount of fluid in right base.	Gland from right supraclavicular region showed metastatic carcinoma	Twelve hundred c.c. of clear fluid aspirated from right side
No. 11. Male, age 64 years (40305)	Onset six weeks previously. Pain in chest; loss of weight and strength. Cough and jaundice	Dilated veins on right side of neck	April 12, 1934—shadow, with fringy margins extending out from right hilus. New-growth	Bronchoscopy done, with diagnosis of primary carcinoma. No biopsy	One course of x-ray treatment; no relief. Died, June 9, 1934
No. 12. R. B. H., male, age 40 years	Onset three months previously, with cough, dyspnea, and hemoptysis; also pain in right shoulder. Loss of weight and strength	Emaciated. Dullness in right apex. Râles over same area	Dec. 21, 1926—complete consolidation of right upper lobe to level of seventh rib posteriorly. Jan. 31, 1927—dense shadow now reaches to level of eighth rib posteriorly. Margins always sharply defined. Trachea displaced to left. March 24, 1927—entire right side now opaque. Diagnosis: primary carcinoma of lung	Bloody fluid aspirated from chest. Cells reported malignant by pathologist (Dr. Leake)	Discharged unimproved. Died a few months later

Case	Symptoms	Physical signs	X-ray findings	Pathologic report	Remarks
No. 13. Male, age 52 years (31725)	Sick for only six weeks. Began as a "cold." Cough, dyspnea, expectoration, pain, and fever.	Dullness, right side. Enlargement of veins of neck. Blotchy rash	Consolidation of right upper and middle lobes. Fluid at right base. Infiltrative metastasis to left side	Bloody fluid aspirated and studied by Dr. J. A. McIntosh, who regarded it as an exudate of malignancy	Died two months after discharge

Case	Symptoms	Physical signs	X-ray findings	Remarks and subsequent course
No. 14. M. S., female, age 54 years	Loss of weight was gradual. Onset with cough ten months earlier. No hemoptysis. Anorexia previous two weeks. Diarrhea with 10 to 12 stools per day	Emaciated; no other physical findings	Oct. 8, 1934—sharply circumscribed area of increased density of right upper lobe, 10 × 7 cm. Primary carcinoma. Gastro-intestinal tract negative	Patient very weak, dehydrated. Bronchoscopic study negative except for purulent secretion from right bronchus. Tumor held in check by x-ray therapy, but patient grew progressively weak and emaciated, and recently died
No. 15. Male, age 59 years (35059)	Duration, eight months. Cough, fever, exhaustion, dyspnea, and hoarseness	Lost ten pounds weight. No râles. Harsh breath sounds on right side	Large shadow in right hilus, with infiltrative borders. No atelectasis. Carcinoma of right bronchus	Bronchoscopy done; not satisfactory. Tissue removed reported as chronic inflammatory. No changes after two courses of x-ray treatment. Patient was found dead in bed, five months after first visit. Massive bronchial hemorrhage
No. 16. G. R., male, age 60 years	Onset nine months previously. Cough, with thick white sputum. Pain in left chest. Profuse sweats for two weeks	Emaciated. Tenderness on pressure over left iliac bone and hip. Resonance impaired over both apices. Numerous râles	June 25, 1929—irregular area of increased density of right upper hilus. Atelectasis of lower portion of right upper lobe. Slight elevation of right diaphragm. July 24, 1929—complete opacity of right chest. Probably both atelectasis and fluid. No displacement. Opinion: carcinoma of right hilus	Died, Sept. 20, 1929. No autopsy
No. 17. A. H. W., male, age 60 years	No cough or hemoptysis. Pain in lumbar region and left chest, with slight dyspnea on exertion	Fairly well developed. Limited motion of right chest, with dullness. Voice sounds distant over same area	Nov. 19, 1932—entire right chest filled with fluid. Nov. 22, 1932—same. Nov. 28, 1932—after aspiration right middle lobe shows a rounded circumscribed mass (tumor). Dec. 2, 1932—same.	Chest fluid showed round cells with foamy cytoplasm. Discharged unimproved. Nausea, vomiting, and restlessness. Died
No. 18. J. W. J., male, age 39 years	Onset three months previously, with hemoptysis and pain beneath right shoulder and axilla. Marked loss of weight	Emaciated. Decreased expansion on right. Dullness in right apex about two inches in diameter. Diminished breath sounds. Increased voice sounds	Nov. 24, 1931—atelectasis of right upper and middle lobes, with tumefaction of center right upper lobe. Elevation right diaphragm. Dec. 13, 1931—re-expansion of middle and lower lobes. Tumor mass more definite in upper lobe	Aspirated chest fluid bloody. Numerous courses of x-ray treatment brought about improvement temporarily, but patient subsequently died

Case	Symptoms	Physical signs	X-ray findings	Remarks and subsequent course
No. 19. G. E. H., male, age 52 years	Onset, ten months previously, with cough and weakness. For part of two months has had hemoptysis. Some dyspnea	Râles over left upper lobe. Marked emaciation	Aug. 26, 1933—opacity of entire left upper lobe, with a circumscribed shadow of a mass (4 × 3 cm.) in left upper hilus. Heart and mediastinum displaced to left and left diaphragm elevated. Right lung and left lower lobe clear	Tumefaction held in check by x-ray, but general condition of patient very poor
No. 20. Male, age 61 years (1871)	Onset, 17 months earlier. Pleurisy with effusion. Cough, dyspnea, and pain in chest. Fifteen pounds loss in weight. Bloody expectoration; hoarseness	Dullness in right lower lobe. Increased fremitus. No fever	Mass in right costophrenic angle arising from hilus. Primary tumor	Wassermann negative. Patient died shortly after x-ray examination
No. 21. Male, age 67 years (28337)	Onset, six months previously. Pain in right shoulder and arm. Cough and expectoration. Dyspnea	No loss of weight. Clubbing of fingers. Dullness in right upper lobe	Tumor mass in right upper lobe. Primary carcinoma, with several small nodular metastases	Wassermann negative. No Horner's syndrome. Died three months later
No. 22. Female, age 63 years (33610)	Onset, six months earlier. Dyspnea, pain in right shoulder, and cough. No hemoptysis	Lost 13 pounds in weight. Dullness in right chest	Tumor filling posterior upper two-thirds of right chest. Fluid in right base. Opinion: primary carcinoma	Numerous aspirations of clear fluid. Five courses of x-ray treatment. Gradual regression of tumor and less secretion of fluid. After three years, the chest shows a retracted atelectasis of right upper lobe, with mediastinum drawn over and some diaphragmatic adhesions. No x-ray treatment for two years, but patient free from symptoms
No. 23. Female, age 52 years (30699)	Chest pains, cough, and dyspnea for one month. Slight fever. Lost 12 pounds in six months	Dullness on right side. No palpable glands	Aug. 15, 1930—effusion, right side; probable tuberculosis Nov. 7, 1930—after aspiration, tumor mass in mid-lung field on right	Died a few hours after aspiration of bloody fluid. No autopsy
No. 24. Female, age 67 years (32781)	Symptoms of six months' duration. Pain and dyspnea; no hemoptysis. Lost 60 pounds. No fever	Dullness in right upper lobe, and râles all over	Oct. 13, 1932—right upper lobe airless. Tumor mass at right upper hilus. Metastases throughout the other lobes	No symptoms referable to other organs than lung. White blood count, 12,650. Normal differential count. Died, Oct. 19, 1932.
No. 25. Male, age 71 years (3199)	Symptoms of five months' duration. Cough outstanding symptom. No pain except on coughing. Yellow sputum	Dullness over large ovoid mass in right anterior chest	Opacity of entire right side. No displacement of heart or mediastinum	Lived about two months after discharge. Mass ulcerated chest wall before death

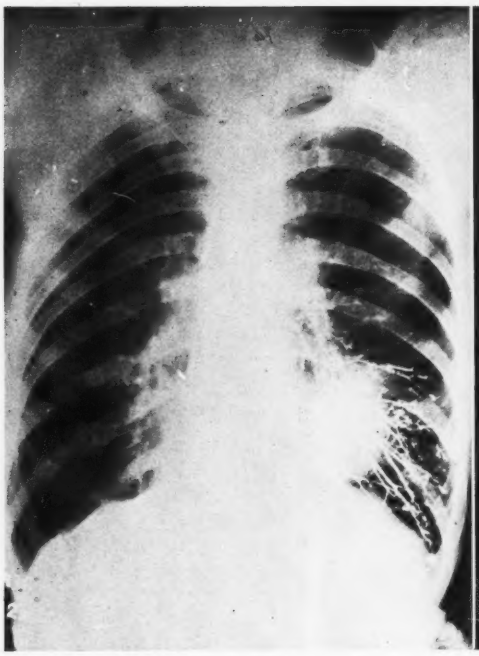

Fig. 5-*A*. Case 9 (see table). Lipiodol injection shows that the tumor does not involve the primary bronchi. The distal bronchi terminate abruptly at the borders of the tumor.

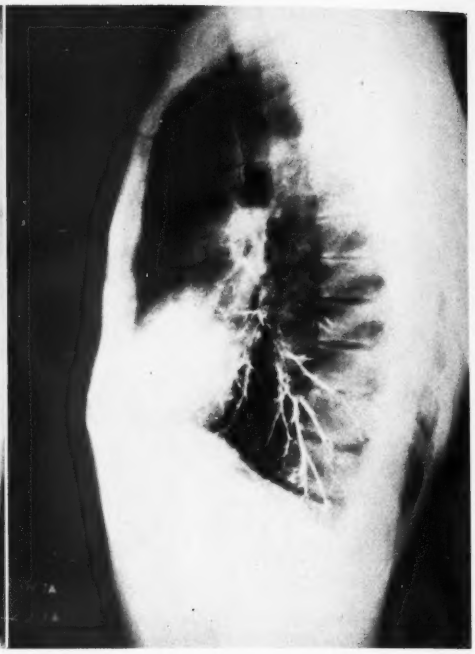

Fig. 5-*B*. Same case as shown in Figure 5-*A*. Lateral view shows that the bronchi which extend beyond the tumor are posterior to it.

biopsy examinations of metastatic deposits. The pathologist was able to find malignant cells in the aspirated fluid from two patients; the thirteenth was diagnosed by the bronchoscopist. In ten of these 13 cases, the diagnoses were made definitely or the possibility of primary carcinoma pointed out by the roentgenologist. Of the remaining three, one was mistaken for pneumonia, one was reported as an abscess, and one as multiple abscesses. The latter two interpretations were correct, but it was not recognized that the abscesses were complications. In the other 12, there was complete accord in the opinion of the clinicians and roentgenologists regarding the diagnoses. The symptoms, roentgenologic appearance, and subsequent history all combined to eliminate any doubt.

A statistical study shows that this group conforms to nearly all those previously studied. There were 20 males and 5 females; the oldest was 72 and the youngest 28, the average age being 55. Twenty of the tumors were on the right side and five on the left. Classification according to the grouping of Kirklin and Paterson is as follows:

Bronchial	14
Parenchymal	6
Late	5

Fluid was present in only nine patients and was sanguinous in five. It was difficult at times to decide whether a consolidation was all tumor or tumor with atelectasis. The films were carefully reviewed, however, and in 13 of the 25 patients we believe atelectasis was present. Bronchiectasis was never diagnosed roentgenologically, but was found once by the pathologist at necropsy. Four patients were known to have had abscesses, although these were apparent in the roentgenograms in only two of the four cases. In the other

two considerable time elapsed between the roentgen-ray examination and the necropsy.

Differential Diagnosis.—In the last stages, the pathologic evidence is so massive that primary carcinoma of the bronchus may be mistaken for almost any extensive infection. From the history and physical signs it may be easily confused with tuberculosis, yet it is not likely to be confused roentgenologically unless we have a tuberculous pneumonia involving the entire lobe.

In our series of cases, lung abscesses proved the most difficult from the point of view of differential diagnosis. When near the hilus they resemble a bronchogenic carcinoma, with its radiating, strand-like infiltrated border. When in the central part of the lobe, the abscesses may appear to be of the parenchymal type. A study of our films did not reveal any points of differentiation, and at times even the clinical history was not conclusive.

Benign tumors, as adenomas and fibromas, cast solitary shadows with sharply circumscribed borders. These are more likely to be mistaken for metastatic tumors than for primary carcinomas.

The differential diagnosis between aneurysms and primary carcinomas of the lung is at times difficult. This was true in one of our recent cases. The patient was a male, 43 years of age, who came into the hospital because of persistent chest pains, dyspnea, cough, and repeated small hemoptyses. Physical examination revealed a sub-febrile temperature, and signs of massive consolidation of the left lung. The usual physical signs of aneurysm were absent. The Wassermann test was positive. There were no tubercule bacilli in the sputum. Roentgen-ray examination showed a consolidation of almost the entire left lung except the apex and costophrenic angle. The trachea and the mediastinal structures were displaced toward the affected side and the left diaphragm was paralyzed. The roentgenologic diagnosis was primary carcinoma with atelectasis. A bronchoscopic examination was reported unsatisfactory and the conclusions indeterminate. At necropsy, a large saccular aneurysm was found arising from the descending aorta. It had completely obliterated the left pulmonary vein and the left primary bronchus, and had eroded the bodies of the third and fourth thoracic vertebræ. That this case was not an exceptional one is illustrated by the reports in the literature. Clerc (3) reports two cases, Deschamps and Mourrut (4) report one, and Deschamps and Schwab (5), one. In three of these, all of which came to necropsy, the diagnoses were so certain from a clinical point of view that radiation therapy was given.

Another case which was diagnosed as primary carcinoma of the lung proved at autopsy to be an endothelioma of the pleura. Roentgenograms showed a complete consolidation of the entire right lung except for the apex and costophrenic angle. There were metastases in the opposite lung, but the radiographs showed no evidence of the displacement of the heart or mediastinum.

Technic.—It is our practice to make stereoroentgenograms in every case of suspected neoplasm of the lung, but we are convinced that if stereoroentgenograms are relied upon solely, many will not be discovered. Figure 1 illustrates the findings in the first examination of a patient who later developed a consolidation of the entire left lower lobe, and at autopsy was found to have a primary carcinoma. A postero-anterior view of the chest showed a few changes at the left cardio-phrenic angle, but fluoroscopy in the oblique view revealed an irregular area of increased density behind the cardiac shadow, and furnished the only clue that led to the correct diagnosis. In addition to the fluoroscopic examination, films made in the lateral position are generally regarded as indispensable. We have been impressed by the value of a film, made on the Bucky diaphragm, with sufficient density to make possible a differentiation of the conglomerate shadows which make up an opacity in the lung-field.

In addition to these relatively simple technical procedures, it is at times advisable to continue the roentgenologic study after certain special procedures have been carried out. These special procedures may include the aspiration of fluid, the production of an artificial pneumothorax, or the injection of an opaque oil into the bronchial tree. It is rather doubtful if artificial pneumothorax or bronchography should be resorted to if a skillful bronchoscopist is available. Unless the bronchoscopic examination is performed skillfully, we believe more information may be obtained by employing the radiographic and fluoroscopic methods that have just been outlined. Even though the roentgenogram may not lead to a positive diagnosis of primary carcinoma of the lung, it is more valuable than any other measure in determining the location and extent of the pathologic condition.

SUMMARY

1. Twenty-five fairly definitely proven cases are reported: in 13 of these there is some pathologic confirmation of the diagnosis.

2. Until every city is provided with a skilled bronchoscopist, the burden of recognizing primary carcinoma of the lung will rest on the shoulders of the roentgenologists.

3. While there is no pathognomonic roentgenologic appearance, there is a picture which, when present on only one side, should always suggest a primary new-growth to the radiologist. It should then be regarded as malignant until proven otherwise.

4. Biopsy material removed by the surgeon or bronchoscopist to-day offers the most reliable method of making this differentiation.

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A ROENTGEN CONSIDERATION OF MEDIASTINAL TUMORS[1]

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THE management of intrathoracic disease is peculiarly the responsibility of the roentgenologist for his is the method of accurate detection, differential diagnosis, indication and guide in therapy, and in certain conditions his may be the healing agent necessary for the optimum result. This applies especially to intrathoracic and more particularly to mediastinal neoplasms, conditions which were rarely recognized in the pre-roentgen period and, if recognized, could not be successfully treated by methods known at that time.

The study of mediastinal tumors, as to their early recognition and accurate classification, should receive our earnest consideration; patients suffering from these lesions may be benefited either by their surgical removal or control, and, in some instances, their eradication by roentgen therapy.

Incidence.—It is agreed by all observers that the number of reported cases of mediastinal tumors has increased rapidly during the past decade or two, but there is no agreement that this represents an actual increase in the incidence of the disease. Just as fracture statistics and those of many other medical problems have undergone marked revision under the influence of roentgen knowledge, so figures dealing with neoplastic disease as a whole bear careful analysis. We must all recognize that lessened infant and childhood mortality has increased the span of life, so that the average is advanced more than one-third, and that under these conditions, tumors and degenerative diseases are to be encountered more frequently.

To facilitate the presentation of the particular division of intrathoracic tumors assigned to us in this symposium, we have elected to review briefly the essential features of our own series of cases examined and treated at the Harper Hospital. During the period from 1922 to the present time, we have examined 60 cases of all types of mediastinal neoplasms. They represent less than 1 per cent of all the neoplasms coming under our observation during this period, a fact which indicates their relative infrequency.

Mediastinal tumors should be identified and classified according to history, clinical investigation, roentgen examination and, in some cases, microscopic examination of tissue removed for biopsy.

Pathologic Considerations.—Mediastinal tumors are either primary or secondary. Primary tumors may originate in the lymph nodes, connective tissue, thymic or thyroid gland, and in the blood vessels of the mediastinum. The classification of the primary tumor is usually more difficult than of the secondary as the latter is of the same nature as the mother tumor, which can usually be identified by biopsy. Mediastinal tumors as a whole may be further classified as benign and malignant. In the benign group are placed the following:

1. Cysts (echinococcus, dermoid, etc.);
2. Ganglionic neuroma;
3. Fibroma;
4. Chondroma;
5. Lipoma;
6. Aneurysm.

A classification of malignant mediastinal tumors is more difficult for the reason that pathologists vary in opinion as to the histogenic nature of many of these neoplasms, but, for practical purposes, the following grouping has been found satisfactory:

1. Lymphoma (lymphosarcoma, pseudoleukemia, aleukemic leukemia, lymphatic leukemia, malignant granuloma or Hodgkin's disease, and thymoma);

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2. Sarcoma, as a rule, originating from areolar connective tissue (fibrosarcoma, spindle-cell sarcoma, and alveolar cell sarcoma);

3. Carcinoma of thymic and thyroid origin;

4. Teratoma.

Clinical Symptomatology.—The essential clinical features of these tumors are well known and have been thoroughly discussed in medical literature, so that a detailed consideration need not form a part of this presentation. We wish, however, to call attention to a few of the less common symptoms which have been observed by us. The secondary effects of very large tumors, in addition to the symptoms of respiratory embarrassment, may produce marked edema of the neck and face; in one of our cases a pronounced conjunctivitis was one of the outstanding findings and accompanied the edema. Mention is made of these unusual features as they enter into the technic of roentgen therapy. In several of our cases, the edema and respiratory difficulties were of such severity that treatment could be given only while the patient was being sustained by the administration of oxygen. Since heavy radiation treatment may increase the edema and respiratory difficulty, it sometimes appears advisable to resort to the fractional method of treatment with smaller doses in cases in which the indications for such a procedure exist.

Hemorrhage is to be mentioned as a relatively rare but important complication. In one of our cases there were several hemorrhages which, together with the roentgen manifestations, pointed to a pulmonary rather than to a mediastinal tumor. However, at autopsy, it was found that the tumor was primarily in the mediastinum, the hemorrhage having occurred as the result of a ruptured blood vessel caused by pressure from the tumor. The conclusion is that hemorrhage does not indicate that the neoplasm has its origin in the pulmonary tissues.

While the importance of a history and a careful clinical investigation is recognized, the value of a complete roentgenologic examination cannot be over-emphasized. Adequate co-operation between the clinician and roentgenologist is of utmost importance.

Roentgen Findings.—Roentgen procedures have increased in number and scope due to technical development and the introduction of associated forms of investigation. However, a careful fluoroscopic and roentgenographic study of the suspect is still a dominating procedure. We need not emphasize the necessity of adequate ocular accommodation before fluoroscopy is attempted. Films should be made in all important positions; we feel that the study in the lateral position is most important.

By these procedures, in addition to the information regarding the size, shape, configuration, and location of tumors, secondary changes may be demonstrated which are the effect of pressure changes on surrounding structures. Outstanding among these are atelectasis of all or part of one or more lobes, and pleural effusion. Both of these may be so pronounced that they may entirely obscure the image of the primary lesion. Some observers are of the opinion that pleural effusion is an indication of pleural metastases, but in several cases we have observed it to be the result of pressure by the tumor against the vessels.

Some writers have drawn up certain criteria by which they attempt to establish an absolute differential diagnosis of the various types from the roentgen image alone. In our experience, shadow changes produced by some of the mediastinal tumors are not always constant; for instance, Hodgkin's disease does not always produce a shadow with sharply defined smooth borders. Not infrequently its edges are hazy and irregular, gradually blending with the shadows of adjacent pulmonary structures. We are further of the opinion that too much importance has at times been placed on the phenomenon of pulsation. In our experience, expansile pulsation is not always a safe index

of an aneurysm, as a few cases of neoplasm have exhibited it, and at times even with most careful study the presence or absence of pulsation cannot be detected in the fluoroscopic image. Of the accessory methods, the administration of barium mixture is an aid in demonstrating the relationship with the esophagus, especially the degree of encroachment upon its lumen. On the other hand, the intratracheal instillation of lipiodol often permits the visualization of the degree of encroachment on the pulmonary tissues. In certain instances, especially those cases complicated by pleural effusion, induced pneumothorax proves of distinct advantage.

Therapeutic Test Dose as a Method of Differentiation.—For the last ten years, an increasing effort has been made to utilize the variation in the radiosensitivity of mediastinal tumors as a guide in their differential classification. This method consists of the administration of the largest irradiation dose over the tumor area which can be tolerated without injury to the normal tissue (as a rule, 110 to 130 per cent s.u.d.). The variation in the response of tumors is then estimated and used as an index of their differentiation. It is a well known fact that the degree of radiosensitivity of the neoplastic tissues is governed in a general way by the cellular characteristics of the neoplasm. From the response to radiation, certain conclusions may be formed concerning the morphologic nature of the tumors irradiated.

The neoplasms of the mediastinum are composed of cellular elements which, in the scale of radiosensitivity, show the greatest variation. Some of them disappear very rapidly following irradiation, others remain refractory, and still others disappear slowly. By making use of this behavior phenomenon, we may place all mediastinal tumors in several groups.

Group 1.—Tumors arising from the lymphocytic cell element, such as lymphosarcomas, thymomas, pseudoleukemias, and lymphatic leukemias, which will entirely disappear within from four to ten days following the administration of a therapeutic test dose.

Group 2.—Tumors originating from the reticulo-endothelial cells of the mediastinal lymph glands and the thymus, such as Hodgkin's disease, Sternberg type of hyperplastic tuberculosis, and endothelioma. These tumors respond more slowly, being reduced within ten days following the administration of a therapeutic test dose to one-half their original size, and disappearing entirely in about six weeks or longer following the treatment.

Group 3.—Other primary mediastinal tumors, which have their origin from the areolar tissue (such as fibrosarcoma, large round-cell sarcoma), are carcinoma of the thymus and thyroid glands, and teratomas. These tumors show some reduction in size following exposure, but rarely disappear at the end of six weeks. They may be said to have a rather low degree of radiosensitivity, having a latent period of growth and then showing evidence of uncontrolled increase in size.

Group 4.—Benign tumors of the mediastinum (lipoma, chondroma, fibroma, neuroma, dermoid) or pseudo-tumors (aneurysms, mediastinal abscess, mediastinal effusion), with the exception of fibroma, are not influenced by radiation. Fibromas probably do respond—but very slowly—and in this respect they manifest the same response as is observed in uterine fibroids.

While it is recognized that the sharp differentiation and the assignment to the above groups may in some cases form a source of error, nevertheless, it is felt that in practice the method is of sufficient value to recommend its use.

A review of our cases shows that 48 per cent fall into Groups 1 and 2, indicating that they represent lymphosarcoma and Hodgkin's disease, and since grouping by the therapeutic test dose is of great value in this instance, we may conclude that a rather large group may be safely classified as a result of its use. On the other hand, the benign tumors, perhaps with the exception of fibromas, will show no response to the application of the therapeutic test

dose, and they may be separated on this basis. A differentiation of the latter group, from occasional refractory malignant neoplasms, is made from the fact that observation over longer periods following the treatment will show that very little progress in the growth has taken place, whereas the more refractory malignant neoplasms in the meantime would have continued to increase in size. Thus by considering all factors, one is able to segregate in practice the majority of the mediastinal neoplasms, the unclassified group shrinking down to something less than 30 per cent.

Application of the therapeutic test dose would by no means jeopardize surgical consideration where and when it is indicated. A review of the literature pertaining to surgical removal of mediastinal tumors shows that while some brilliant results have been obtained in the removal of benign neoplasms, nearly all cases suffering from malignant mediastinal tumors have died either as a result of extension or metastases in a few years. Thus, since it cannot be said that the application of a therapeutic test dose would produce a harmful delay in the malignant cases, and if carried out with a non-injurious dose as regards normal tissues, in the benign cases a surgical intervention may always be undertaken at a later date without any greater risk.

It seems to us that the best procedure in the treatment of mediastinal tumors is first, in all instances, to apply radiation therapy in the form of a therapeutic test dose, and to reserve for surgery those cases which, as a result of the investigation, have been shown to be benign, or those in which the diagnosis in spite of all investigation remains doubtful.

CONCLUSIONS

In summarizing the entire subject, it becomes apparent that the use of roentgen rays, both from the diagnostic and therapeutic standpoints, plays a decisive rôle in dealing with intrathoracic and especially mediastinal tumors. A consideration of the clinical features may help to enlarge the field of knowledge, and surgical procedure may, in certain instances, prove more advantageous, but the application of roentgen methods will remain the most important.

EXTRA-PULMONARY TUMORS OF THE THORAX[1]

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THE extra-pulmonary and extra-mediastinal tumors of the thorax include a large variety of uncommon lesions, for the most part rare in the experience of the clinician, the roentgenologist, or the pathologist. For the purpose of this symposium an artificial relationship based on location has been imposed. In such an heterogeneous mixture, it has been difficult to deduce any semblance of reasonable relationship between the individual types of tumors. The following arrangement, by origin as well as location, may serve to orient the reader in some degree.

I. Tumors of the thoracic wall proper:
   - (*a*) Non-malignant primary neoplasm;
   - (*b*) Malignant primary neoplasm;
   - (*c*) Metastatic malignant neoplasm;
   - (*d*) Ganglionic neuroma and neurofibroma.

II. Tumors of the pleura:
   - (*a*) Extrinsic source;
     - (1) Metastatic malignancy,
     - (2) Hydatid,
     - (3) Tuberculoma,
     - (4) Fibrinoma.
   - (*b*) Intrinsic source;
     - (1) Endothelioma of pleura,
     - (2) Chondroma of pleura.

III. Tumors of other local origin:
   - (*a*) Aneurysm of the innominate artery;
   - (*b*) Embryonal rests;
   - (*c*) Primary carcinoma of the pulmonary apex (superior pulmonary sulcus tumor).

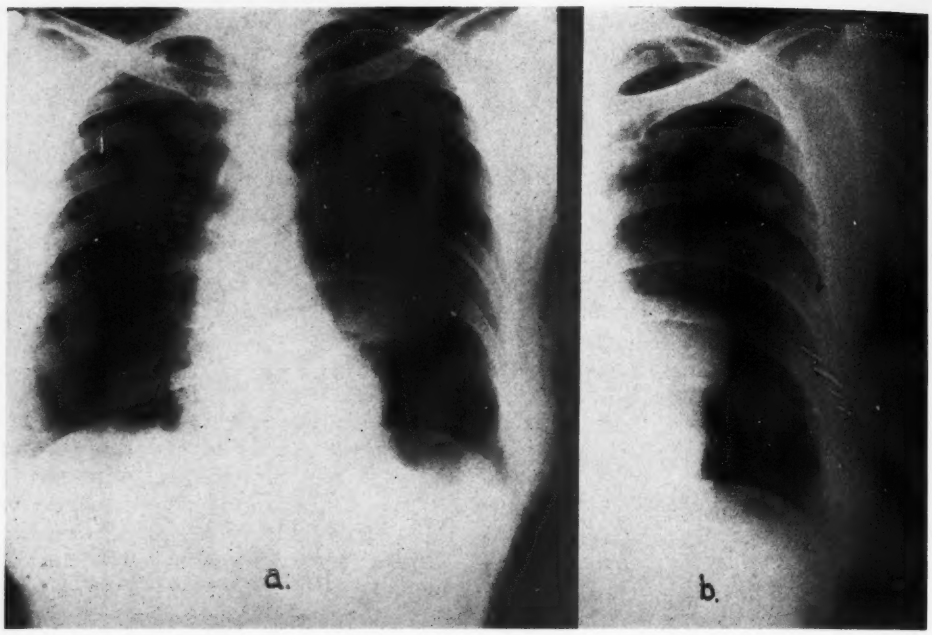
I.—TUMORS OF THE THORACIC WALL PROPER

(*a*) The large group of non-malignant primary neoplasms of the thoracic wall includes the tumorous hyperplasias on any one or more of the mesodermal derivatives which are involved in the formation of the wall proper, such as lipoma, fibroma, myxoma, chondroma, osteochondroma, and angioma. As a group, these non-malignant thoracic wall tumors will present a prolonged history of known mass, and pain, dependent upon the degree of pressure on intercostal nerves or pleura. Dyspnea is present only if the tumor should attain sufficient size to embarrass the respiratory function. Pleural effusion is uncommon.

These masses may obscure the underlying pulmonary fields in a degree corresponding to their thickness and specific density. As a rule they will be found as rather sessile tumors, sharply marginated, and homogeneous in character of shadow. Both fibroma and myxoma have been reported as presenting, both externally and internally, as a "collar-button mass," or as spreading the ribs apart by the intercostal tumefaction.

Chondroma, osteochondroma, and osteoma are rather familiar to the roentgenologist. They are most common in individuals who have multiple osteochondromas of the familial type. Roentgenographically, the last two present architectural characteristics which distinguish them definitely from the other connective tissue tumors. Similar comment applies to benign giant-cell tumor of the rib.

[1] Presented before the Radiological Society of North America, at Memphis, Tenn., Dec. 3–7, 1934.



Figs. 1-*A* and 1-*B*. Case I. L. G., No. 323,608, female, aged 33 years. Angioma of the thoracic wall with calcified phleboliths. Fig. 1-*A*. Frontal view of entire thorax, pneumothorax for pulmonary tuberculosis, pleural irregularity left axilla. Calcified phleboliths. Fig. 1-*B*. Detail showing area of angioma of the thoracic wall.

The angioid neoplasms present certain changes which may serve to distinguish them. Although the other tumors of this general group may produce palpable external masses, or local changes in percussion note, depending upon total depth of tumor or the degree of compression of the underlying lung, the angioid non-malignant tumor will present a slight thrill on palpation and auscultation. On the roentgenogram these will often show an occasional calculus similar to a phlebolith in its vascular channels (Case I, Figs. 1-*A* and 1-*B*).

(*b*) The malignant primary tumors of the thoracic wall include chondrosarcoma, osteochondrosarcoma, and osteogenic sarcoma of the ribs, "giant sarcoma," myxo-angio-endothelioma.

The first three of these, arising in or from the bone, cartilage, or periosteum of the ribs, are distinguished from the non-malignant group by the much shorter history, the destruction of the bony cage locally, and by more severe pain and pleural effusion. They tend to progress rapidly and may or may not show evidence of new bone formation as is the character of the primary bone neoplasms (Case II, Figs. 2-*A*, 2-*B*, and 2-*C*. Courtesy of Dr. W. A. Irwin, of Detroit, Mich.)

In this group it is important to determine the presence or absence of viscero-parietal pleural fixation over the tumor as an indication of the degree of pulmonary invasion.

We have previously reported a spindle-cell osteogenic sarcoma arising in a giant-cell tumor of the rib, with neoplastic involvement of the pleura. In that patient a diagnostic or preparatory pneumothorax, with subsequent films, was of great assistance in the determination of the extent of involvement, as well as offering further information as to the nature of the tumor.

The giant sarcoma described by Lilienthal and Klemperer may attain gross size. It is a highly cellular fibrosarcoma, most

Figs. 2-*A*, 2-*B*, and 2-*C*. Case II. G. L., female, aged 13 years. (Courtesy of Dr. W. A. Irwin, Detroit, Michigan.) Chondrosarcoma, arising from sixth rib. Fig. 2-*A*. Gross neoplasm obscuring the right pulmonary structures. Fig. 2-*B*. Study with Potter-Bucky diaphragm. Involvement of fifth and seventh ribs by pressure of primary tumor arising from the sixth rib. Fig. 2-*C*. Detail of surgical specimen removed.

common beneath the costal pleura, and may be fairly well encapsulated. Pleural effusion will vary in degree; roentgenologically it would be difficult to differentiate from a large non-malignant tumor or an unevacuated cyst.

The myxo-angio-endothelioma of Davison produced destruction of the neighboring ribs, with tumefaction, both extra- and intra-thoracic, but apparently without marked pleural effusion. It could not be distinguished roentgenographically from any other soft malignant neoplasm arising in the thoracic wall. From the roentgen appearance it might have been either a primary or metastatic malignancy of the thoracic wall.

(*c*) Metastatic malignant neoplasm of practically any origin may involve the thoracic wall. In our clinic the most common have been carcinoma of the breast, osteogenic sarcoma, lymphoblastoma, myeloblastoma, and Ewing's endothelioma of the bone. In general, these involve the ribs or sternum first, and by tumefaction and invasion displace the parietal pleura to obscure or compress the underlying lung.

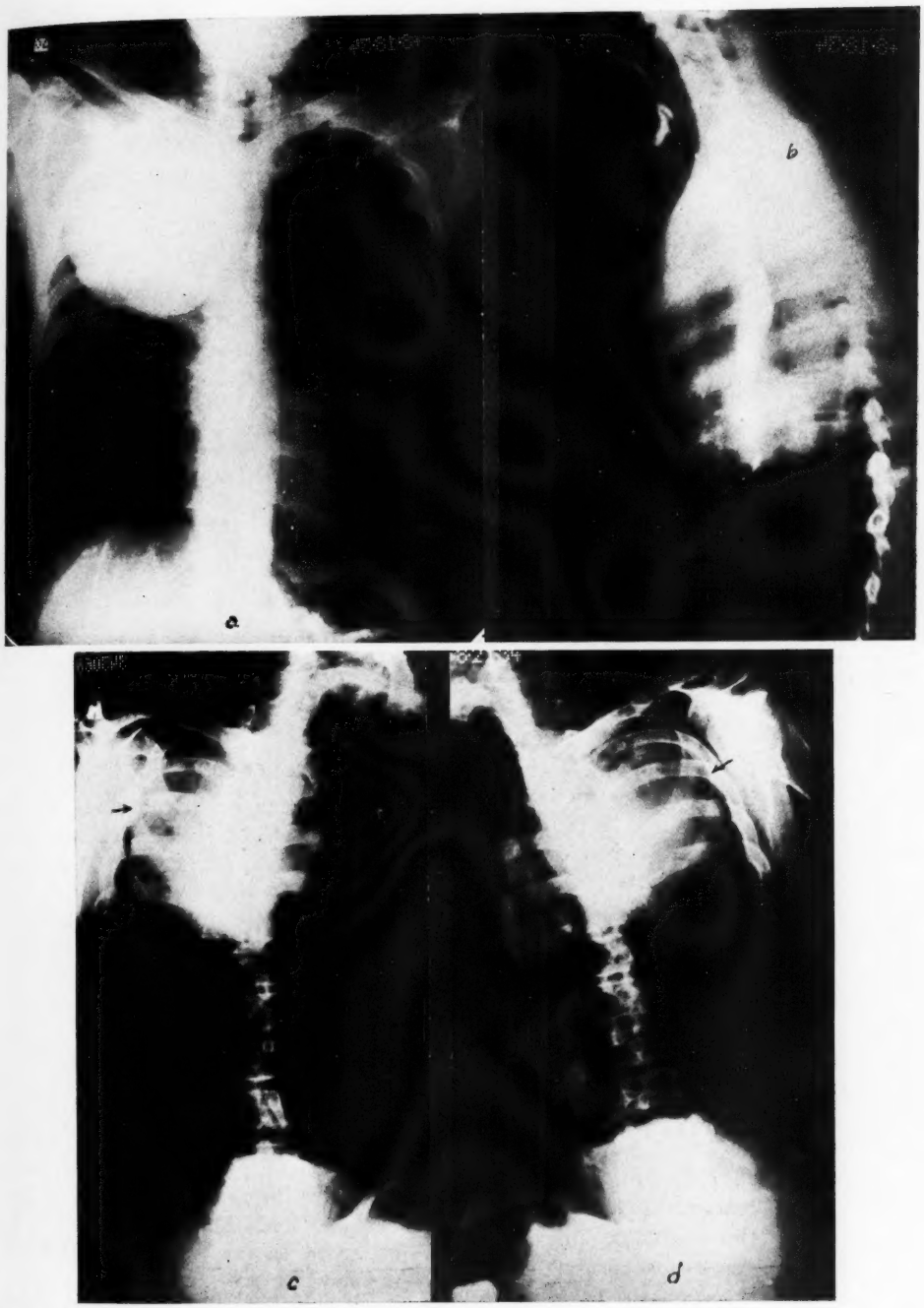
Differential diagnosis of these within the group from primary malignancy of the thoracic wall is rarely possible on roentgen study alone. The osteoblastic bone sarcomas may demonstrate as much new bone in the secondary as in the primary tumor. Careful clinical scrutiny of the patient must be made if no primary source is known.

Therapeutic test of high voltage irradiation will induce a reduction in size, at times a disappearance of metastatic carcinoma of the breast, lymphoblastoma (Case III, Figs. 3-*A*, 3-*B*, 3-*C*, and 3-*D*), and Ewing's endothelioma of the bone. There will be some residual evidence of the neoplastic damage to the bone or pleura. The metastatic carcinoma of breast and lymphoblastoma will show the more rapid response. Myeloblastoma responds more slowly than the above three, is primarily expansile, and of medullary origin. Further, monosseous myeloblastoma is uncommon in the ribs. Osteogenic sarcoma is the least responsive in this group to irradiation. We have not seen metastatic hypernephroma of great size in the ribs.

(*d*) Ganglioneuroma and neurofibroma (neurinoma) comprise another group, rela-

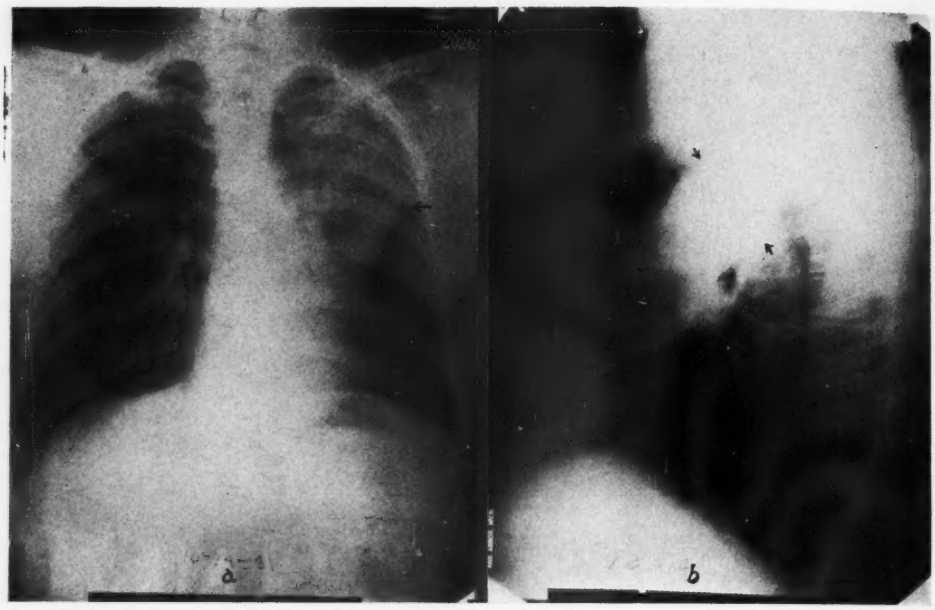
Figs. 3-*A*, 3-*B*, 3-*C*, and 3-*D*. Case III. F. D., No. 332,531, female, aged 24 years. Lymphoblastoma, involving sternum and lung. Fig. 3-*A*. Frontal view, pulmonary infiltration overlying tumor mass, widened sternal shadow. Fig. 3-*B*. Lateral, showing gross involvement of sternum. Fig. 3-*C*. Frontal view, after x-radiation therapy. Fig. 3-*D*. Lateral, following irradiation. Minimal residual defect in body of sternum.

tively rare in the thorax. Ganglioneuroma, arising in connection with the sympathetic system, will predominantly appear in the posterior, or paravertebral gutter, or the



Figs. 5-*A*,[2] 5-*B*, and 5-*C*. Case V. H. R., No. 343,068, male, aged 40 years. Primary carcinoma of bronchus. Gross metastases arising in the pleura, right thorax, compressing the lung. Metastases to kidney and adrenals. Fig. 5-*A*. Frontal view. Fig. 5-*B*. Lateral; some displacement of the esophagus. Figs. 5-*C* and 5-*D*. Oblique projections, Potter-Bucky diaphragm, following pre-operative pneumothorax; show a fixation of lung and pleura by tumor.

[2] Case IV is not illustrated.



Figs. 6-*A* and 6-*B*. Case VI. C. F., No. 202,616, male, aged 30 years. Echinococcus cyst. Fig. 6-*A*. Frontal plane, appearance had been confused with encapsulated empyema. Fig. 6-*B*. Lateral, demonstrating position of cyst in the interlobar fissure. Subsequent surgical removal. Excellent condition after three years.

mediastinum. In time, manifestations of disturbance of the sympathetics involved in the tumor may appear. The roentgen character is usually that of a round or ovoid homogeneous tumor: roentgen differentiation is difficult.

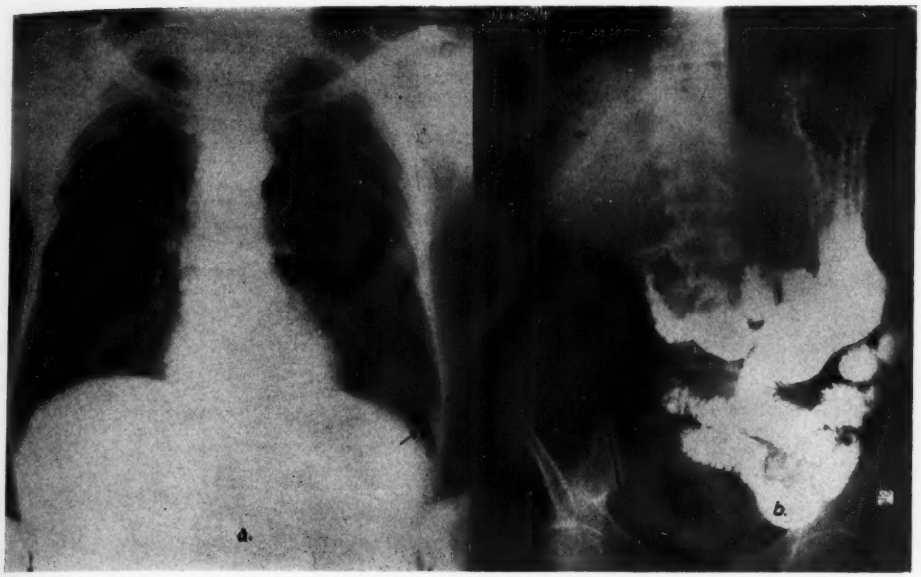
Neurofibroma (von Recklinghausen) or neurinoma in the thorax most commonly is associated with the intercostal nerves. Makkas has recently reported a survey of the published cases, with two neurinomas from his own series, a total of twenty-eight. This neoplasm tends to be either sessile or nodular in the thoracic parietes, or globular when found in the posterior gutter of mediastinum. In the parietal portion of the thorax it may present an appearance similar to neoplastic metastatic involvement of the pleura or a pleural endothelioma. Similar tumors elsewhere in the body or the presence of a known primary neoplasm will assist in the differentiation.

II.—TUMORS OF THE PLEURA

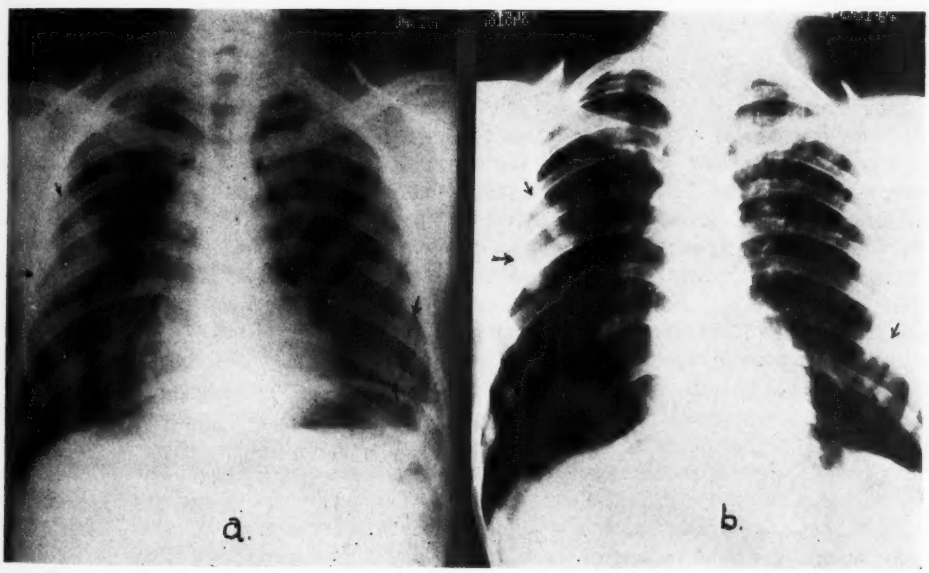
(*a*) The tumors involving the pleura of extrinsic origin include chiefly metastatic malignancy, echinococcus cyst, tuberculoma, and fibrinoma.

(1) Metastatic malignancy may invade, or be implanted in, the parietal pleura. Here again the problems of differentiation discussed above in regard to metastatic involvement of the thoracic wall appear. Carcinoma of the breast (Case IV) and carcinoma of the bronchus (Case V, Figs. 5-*A*, 5-*B*, and 5-*C*) have been the common offenders in our experience. Both of these generally invade rather than become implanted.

(2) The hydatid (echinococcus) cyst found in the thorax has been commonly a pulmonary implant or an extension through the diaphragm from the liver. These masses are usually sharply circumscribed, and are said to present a flocculent deposition of calcium, especially in the cyst wall. However, they may be quite homogeneous



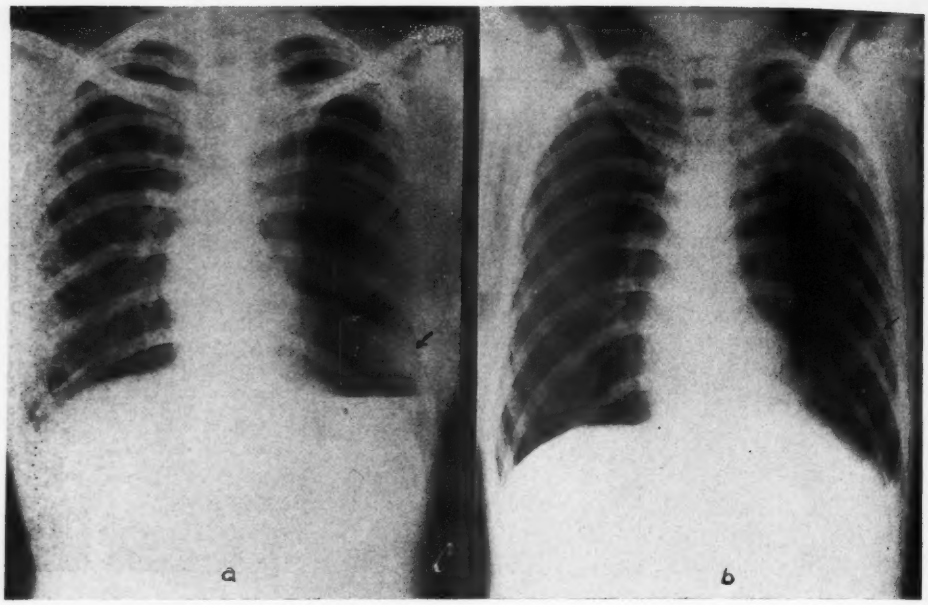
Figs. 7-*A* and 7-*B*. Case VII. H. B., No. 346,548, male, aged 55 years. Hypernephroma, primitive type. Fig. 7-*A*. Pleural metastasis, left axilla. Fig. 7-*B*. Hepatic mass with calcium deposition.



Figs. 8-*A* and 8-*B*. Case VIII. E. M., No. 345,187, male, aged 17 years. Tuberculoma (miliary tuberculosis). Fig. 8-*A*. Routine chest examination; circumscribed tumor mass containing some calcium. Fig. 8-*B*. Study with Potter-Bucky diaphragm for contrast.

in roentgen appearance. If pleural rupture should occur, the subsequent reaction, both clinical and roentgenologic, may simulate severe empyema. They are often clinically silent.

In the past four years at the University

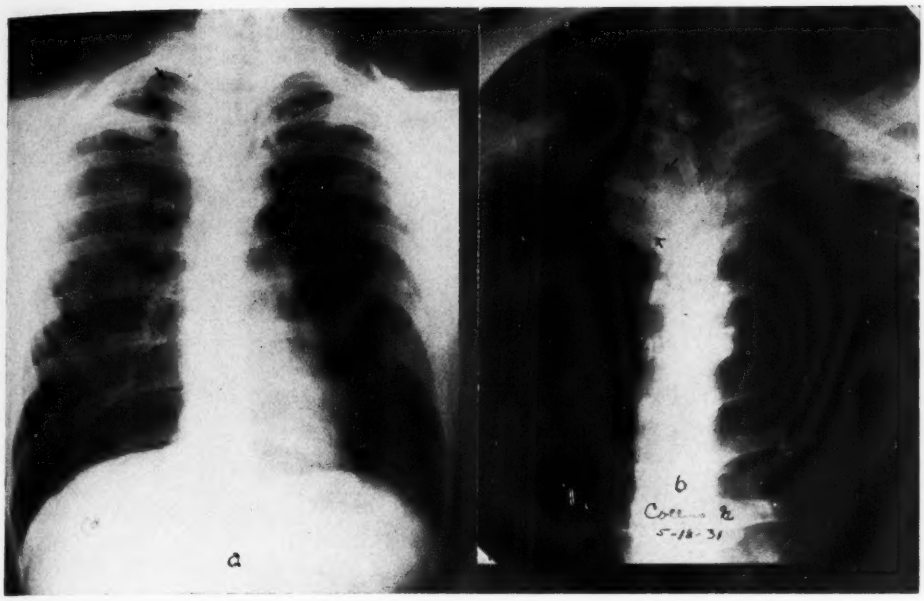


Figs. 9-*A* and 9-*B*. Case IX. J. T., No. 272,038, female, aged 16 years. Fibrinoma (pulmonary tuberculosis, pneumothorax). Fig. 9-*A*. Appearance on July 13, 1932. Fig. 9-*B*. Partial organization with reduction in size, Oct. 4, 1932.

Hospital two patients have presented echinococcus cyst of the pleura. One had been considered a case of pulmonary abscess and secondary empyema. Only when viewed in the lateral and oblique projections (Case VI, Figs. 6-*A* and 6-*B*) was the fusiform encapsulated character demonstrated along the interlobar fissure. A history of the expectoration of typical "noodle" shreds from the cyst wall aided in a positive pre-operative diagnosis. On operation, the tumor was found to be firmly encapsulated in the fissure. The other patient presented a more typical round homogeneous tumor in the lower part of the right long fissure, with no evidence of extension from a subphrenic involvement. Both patients have remained well over two years following surgical removal of their tumors.

Roentgen differentiation from any other roundish encapsulated tumor in the thorax may not be possible. Careful search for a history of exposure to the parasites, serologic study, and evidence of other lesions must be employed for positive diagnosis. On the other hand, recently a patient presented a classical round shadow, as of a cyst encrusted with calcium, in the right lobe of the liver, and a round homogeneous tumor in the lower right lung, with a history of possible exposure to the echinococcus. Biopsy of the kidney revealed a very primitive type of hypernephroma (Figs. 7-*A* and 7-*B*, Case VII), which histologically, would not suggest a papillary cystadenoma of the kidney.

3. In tuberculous infections of the pleura there appear occasionally on the roentgenogram sharply circumscribed areas of evident increase in density, apparently sessile tumor masses lying close to the thoracic wall. Within these there may be some flocculent shadows of calcium. Save for the relatively sharp margination and lack of evidence of coalition of multiple tubercles, one might consider a localized confluent subpleural pulmonary tuberculosis (Case VIII, Figs. 8-*A* and 8-*B*). Upon study at the autopsy table they are found



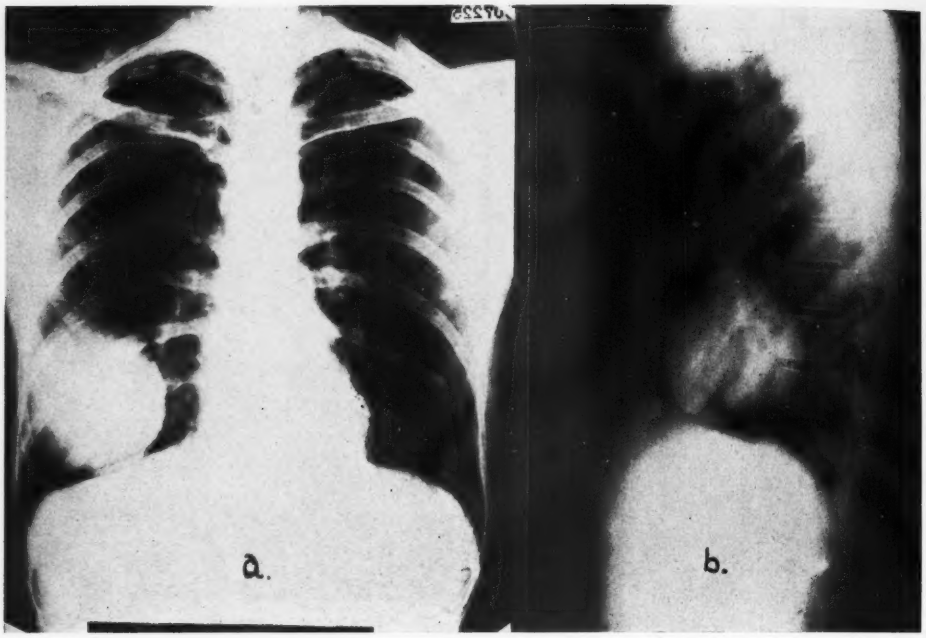
Figs. 10-*A* and 10-*B*. Case X. C. G., No. 255,264, male, aged 19 years. Aneurysm of innominate artery. Fig. 10-*A*. Routine chest examination; small mass, median portion right apex, poorly visualized in this view. Fig. 10-*B*. Detail (Potter-Bucky diaphragm); sharp demonstration of tumor mass.

to be definitely encapsulated soft tumors in or beneath the pleura (parietal in the case cited), with a firm fibrous capsule and containing a creamy, greenish-yellow débris. Such is the appearance of the tuberculoma of the thoracic wall.

4. The other tumor appearing in the tuberculous patient is to be found chiefly with the chronic pleural effusion of tuberculosis. Such a tumor is found, on autopsy or thoracoscopy, to be a more or less organized mass of fibrin, a fibrinoma. It may be adherent to the parietal or visceral pleura, more commonly at about the surface of the effusion in an hydropneumothorax, may dangle in the fluid, or be suspended between the lower tip of the lung and the diaphragm. Occasionally such tumors lie free in the pleural space, and hence may be found in any one of several positions, dependent on the posture of the patient at the time of the exposure of the film. They are homogeneous masses, to be confused at times with true neoplasms or proliferative disease of the parietal pleura. So far as we know, they have no clinical significance (Case IX, Figs. 9-*A* and 9-*B*).

(*b*) The tumors of the pleura of intrinsic origin are quite rare. These are chiefly endotheliomas and the connective tissue tumors, such as chondromas of the phrenic pleura.

(1) Endothelioma of the pleura presents a very confusing complex. The prolonged clinical course may be divided into three phases. The initial period may or may not be accompanied by pleural pain; there is usually some effusion and slight fixation of the thoracic wall on the affected side, but without cough, other pulmonary symptoms, or leukocytosis. In the second period the fluid re-accumulates rapidly after thoracentesis, the fixation proceeds definitely, still without leukocytosis in contra-distinction to the effusion with pleural infection. The fluid may be sanguineous in character and tumor cells may appear in the sediment. In the third period, fixation of the visceral



Figs. 11-*A* and 11-*B*. Case XI. C. B., No. 279,994, male, aged 30 years. Primary chondroma of lung. Fig. 11-*A*. Frontal view. Fig. 11-*B*. Lateral projection; tumor lying between the pleuræ and the fissure.

and parietal pleura usually appears. The effusion, pushing against a rigid thoracic wall, may induce a mediastinal shift. Mediastinal, axillary, and contra-lateral metastases appear.

If diagnostic pneumothorax or thoracoscopy is employed, the pleura will show multiple low nodular elevations at first, with subsequent gross thickening of the pleura and pleural fixation. The invasion of the homolateral lung will take place chiefly along the lymph spaces in the septa.

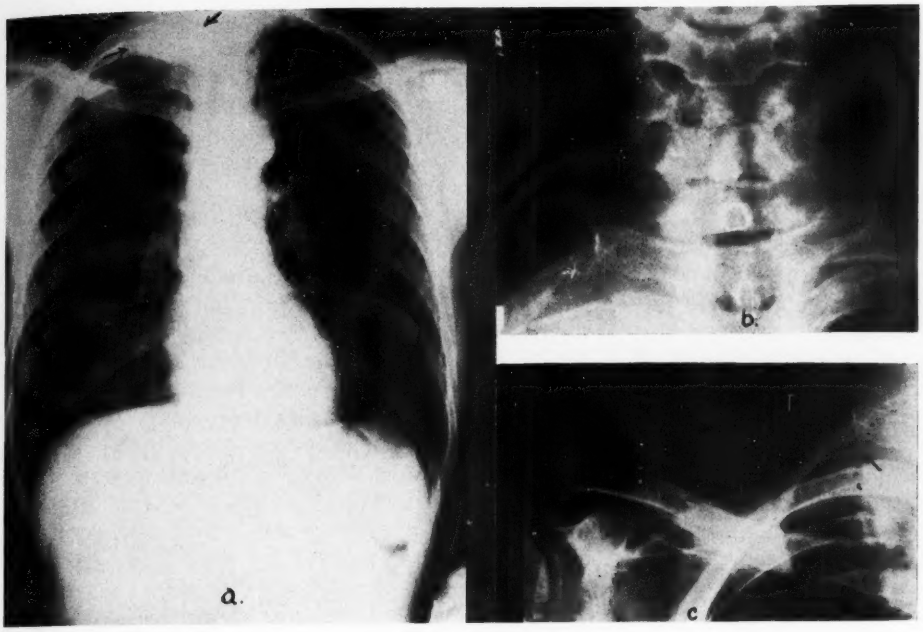
Ewing believes there may be two types of different origin, one arising from the endothelium of the lymph spaces and invasive in type; the other of superficial origin in the lining cells of the pleura, producing nodular masses. The vascular proliferation, nodular arrangement of the cells with caseation, and the presence of giant cells of the Langerhans type may give rise to confusion with hemorrhagic tuberculous pleurisy.

From the roentgen appearance alone, differentiation from tuberculous pleurisy, metastatic carcinoma of the breast, empyema, or extensive neurofibromatosis may be quite difficult. Clinical data and roentgenographic signs, with induced pneumothorax, must be weighed carefully.

(2) Occasionally small connective tissue tumors may arise in the outer layers of the pleura. It is improbable that these can be differentiated by roentgen methods. The small chondromas of the phrenic pleura seem to be the more common—not to be confused with the "pulmonary chondromas" which, apparently, are of embryonal origin.

III.—THE THIRD MAJOR GROUP

This is a miscellany of those lesions which properly do not arise from the thoracic wall or pleura, but which may present roentgen changes by pressure or invasion in the wall or pleura. These are



Figs. 12-*A*, 12-*B*, and 12-*C*. Case XII. W. S., No. 318,498, male, aged 43 years. Primary carcinoma of the pulmonary apex (Primary sulcus tumor). Fig. 12-*A*. Frontal projection; obscuration of right pulmonary apex; questionable changes, first rib. Fig. 12-*B*. Detail, cervico-thoracic junction, showing destruction by infiltration of the first rib and seventh cervical transverse process. Fig. 12-*C*. Detail of pulmonary apex showing rib destruction and tumor.

chiefly aneurysms of the innominate artery, newgrowths from embryonal rests, and the so-called "superior pulmonary sulcus tumor" (which is probably a primary carcinoma from the pulmonary apex).

(*a*) Aneurysm of the innominate artery may obscure only the pulmonary apex, simulating a thyroid tumor, but may also develop a very large globular mass similar to a gross pulmonary cyst, gross neurofibroma, or any other large mass (Case X, Figs. 10-*A* and 10-*B*). Adequate study by clinical and fluoroscopic methods, with detail films, should permit differentiation —the advent of roentgen kymography may prove of value in the identification of these lesions. Destruction of the contiguous bony thorax is rare.

(*b*) The major number of newgrowths arising from embryonal rests in the thorax appear in the mediastinum, and will be discussed by other essayists in this symposium. Occasionally a subpleural teratoma will develop to the right or left of the sternum. Differentiation may be extremely difficult by roentgen methods. Invasion of underlying lung, or compression, may induce pulmonary infiltration or pressure atelectasis sufficient to mask the primary lesion. If the tumor should contain some osseous fragments or if rupture into a bronchus should occur, with expectoration of hair or sebaceous detritus, diagnosis may be more positive.

The teratoids are not so definitely circumscribed as the myxo-lipo-chondromas (echondromas). These are more commonly found nearer the hilum than in the pulmonary parietes. Hickey and Simpson's case contained appreciable calcium. One of the cases (Case XI, Figs. 11-*A* and 11-*B*) which the author reported with Benninghoven contained no gross calcium, was extra-pulmonary in the lower right

thoracic quadrant, and intimately attached to the visceral pleura. They are more or less homogeneous, depending upon the amount of calcium content, relatively sharply circumscribed, and may have a slightly crenated margin. Histologically, they contain cartilage (predominantly), with some lipoid, myxomatous and lymphoid elements in scattered areas. These are probably of embryonal fragment origin rather than metaplasia of the connective tissue elements, the latter being more probable in the case of the local chondromas which appear beneath the diaphragmatic pleura. The intrathoracic chondromas may have no clinical significance except as they become large enough to induce pressure signs and sequelæ in the lung.

(*c*) With the mention above of aneurysm of the innominate artery, some attention must also be given to the so-called "superior pulmonary sulcus tumor." This has been described as a tumor in the apex of the thorax, associated with more or less intense pain in the shoulder and down the arm, Horner's syndrome, destruction of contiguous bone, and atrophy of the hand muscles on the affected side. Pancoast believes that its origin from either lung, pleura, ribs, or mediastinum has not been established, and suggests that the terminology might be revised with further knowledge of the histopathology. Recent necropsy evidence in our clinic, as reported by Jacox, leads us to feel that this is really a mucin-forming primary adenocarcinoma arising from the bronchi of the pulmonary apex. It usually involves the pleuræ and invades the paravertebral soft tissues and bony thorax locally. Metastasis in the suprarenal was found in Jacox' case. Similar pain may be associated in some measure with innominate aneurysm, the obscuration of the pulmonary apex with aneurysm may simulate the infiltration of the neoplasm, and the changes of the Claude Bernard-Horner syndrome may be induced by any lesion which can effect a paralysis of the sympathetic on the affected side. However, only neoplasm could cause the destruction of rib or vertebra which commonly appears with the primary carcinoma of the pulmonary apex (Case XII, Figs. 12-*A*, 12-*B*, and 12-*C*).

Roentgen Examination.—Occasional reference has been made in the discussion above to the methods of roentgen examination in these tumors. Any patient exhibiting signs of changes in intrathoracic pressure as manifest by disturbance of circulation or respiratory embarrassment should be examined first by fluoroscopy.

As a routine procedure the basic film studies should include a stereoscopic frontal and a lateral projection. The fluoroscopic study and basic films may then be supplemented by further projections in one or more oblique planes or, with the patient recumbent, in such a position as seems to most clearly project the involved area.

The lateral view of the thorax has been occasionally used by roentgenologists for some time. Since 1930 we have made it a routine measure in any case of suspected thoracic wall or intrathoracic tumor.

The Potter-Bucky diaphragm has also proved of value in these lesions, although I believe it need be used only in special detail examinations.

In the roentgen study of patients under consideration for thoracic surgery, we find the induction of a pneumothorax and subsequent films of very valuable assistance in the differentiation of an extrapulmonary mass, and an excellent method by which to demonstrate any possible fixation of visceral to parietal pleura at the site. Such examination can be done at the time of preparation of the patient for thoracic surgery.

In conclusion, this series of tumors includes a most diverse and relatively rare group in which differential diagnosis may require extensive and critical clinical study in conjunction with thorough roentgen examination.

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CONGENITAL CYST OF THE LUNG[1]

By JAMES L. DUBROW, M.S., M.D., Veterans' Administration Hospital, *Des Moines, Iowa*

CONGENITAL cysts of the lung, though not frequently encountered, present a pathologic condition important in the differential diagnosis of chest conditions. The following theories have been advanced as to the etiology of congenital cysts: (1) Bronchial maldevelopment—a defective embryologic development of the bronchi resulting in complete or incomplete stenosis of the main bronchus or bronchi, usually of the upper lobe, with distal dilatation of the end branches; (2) alveolar agenesis—defective embryologic development of the alveolar tissue which leaves the bronchi unsupported and consequently causes them to become unduly dilated; (3) defective embryologic development (anlage) of the lymph vessel systems of the corresponding lung.

The cysts may be filled with fluid if the deformed bronchus is completely occluded; if incompletely stenosed they will contain air. While the pathogenesis of congenital cysts can only be surmised, the theories may be of some value in elucidating the pulmonary cystic changes encountered. Clinically the following conditions, amongst others, may be simulated by these cysts:

(1) *Bronchiectasis.*—The congenitally dilated bronchi and bronchioles may retain some mucosal secretions, and if the latter become secondarily infected it may be impossible to differentiate the congenital sacculations from the acquired form, unless the history of the case is clear or the sacculations are so extensive as to point to a universal bronchiectasis.

(2) *Pulmonary Atelectasis.*—The alveolar agenesis affecting a whole lung leads to its arrested development with consequent narrowing of the intercostal spaces, elevation of the diaphragm, and displacement of the heart and mediastinum to the affected side, which on the roentgenogram appears as a unilateral opacity. Lipiodol injection will demonstrate extensive sacculations in contradistinction to acquired massive pulmonary atelectasis in cases in which the main bronchus is completely obstructed.

(3) *Spontaneous Pneumothorax.*—(*a*) Localized, silent—in cases in which the cystic changes involve a whole lobe or the greater portion of it and the congenital stenosis of the bronchus is such that ingress and egress of air are free, the cyst will contain air, and on the roentgenogram it will resemble a localized pneumothorax (or perhaps cavitation); (*b*) valvular—in cases in which the congenital stenosis of the bronchus is such that egress of air is interfered with while ingress is free. The mechanism is that of obstructive emphysema, owing to a check-valve obstruction wherein with each respiration more air becomes incarcerated in the subjacent lung, which dilates and presses upon the mediastinum and the heart, displacing them to the unaffected side; the contralateral lung is thus encroached upon.

In infants, owing to the labile mediastinum and the delicate rib cage, the symptoms, as pointed out by Miller (1), Nelson (2), Parmelee and Apfelbach (3), Croswell and King (14), may become alarming, with acute attacks of dyspnea and cyanosis simulating clinically valvular pneumothorax. The affected side is hyper-resonant or tympanitic on percussion; on auscultation, the breath sounds are absent, heart and mediastinum are displaced to the opposite side, and on thoracentesis there is an escape of air under pressure. However, the roentgenogram fails to show

[1] Presented before the Radiological Society of North America, at Memphis, Tenn., Dec. 3–7, 1934.

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any evidence of a collapsed lung, the entrapped air being intrapulmonary.

Wilson (4) reported a case of obstructive emphysema in an adult, probably due to congenital cystic disease, in which periodic attacks of dyspnea were so severe as to necessitate repeated withdrawals of air in amounts varying from 300 to 700 c.c., with initial reading around minus 1, plus 1; final reading minus 7, minus 3, depending on the amount withdrawn. That he was dealing with a congenital air cyst and not with a spontaneous pneumothorax was demonstrated by the fact that after an induction of an artificial pneumothorax, the outlines of the partially collapsed lung could be discerned. It is thought that in such cases the main bronchus is the seat of an incomplete stenosis whereby more air is allowed to enter on inspiration than can escape on expiration, so that with each succeeding breath more air is retained in the cyst.

According to Eloesser (5), cysts of the lung may be solitary or multiple, or one entire lung may be the seat of cystic degeneration. The writer (6) is of the opinion that, in the last form, the physical and especially the roentgenologic findings may simulate pulmonary atelectasis: the unilateral hemithorax is shrunken, intercostal spaces are narrowed, the homolateral dome of the diaphragm is elevated, and there is displacement of the trachea, heart, and mediastinum to the affected side. On percussion this side is dull, while on auscultation an enfeeblement of the breath sounds is noted, although occasionally tubular breathing and squeaks are elicited. The roentgenogram simulates pulmonary atelectasis. Over-exposure of the film may show transradiant areas, while lipiodol injection will demonstrate extensive sacculations occupying the whole lung. It may be difficult to determine whether these sacculations are congenital or acquired in character and secondary to chronic shrinking tuberculosis, chronic partial bronchial stenosis, or chronic pleurisy and emphysema. However, laboratory data and the history assist in differentiation, as in the case reported by Hermes and Mumme (7) in which the heart was noted on the right side by the mother early after birth although an electrocardiogram failed to substantiate dextrocardia; the roentgenogram showed a typical appearance of pulmonary atelectasis with cardiac displacement to the right. Lipiodol injection demonstrated extensive sacculations, regarded by these authors as due to congenital maldevelopment of the bronchi and alveoli.

A review of the literature on the subject of congenital cysts of the lung suggests that the types encountered may be grouped as follows:

1. Symptomatic:
   - (*a*) Those presenting symptoms and signs simulating valvular pneumothorax wherein the mechanism is that of obstructive emphysema.
   - (*b*) Cystic degeneration of a whole lung simulating pulmonary atelectasis (Tilotson, 8, Eloesser, 5, and Hermes and Mumme, 7).
   - (*c*) Fetal bronchiectasis simulating the acquired form.
   - (*d*) Congenital retention cysts secondarily infected and brought to attention on account of acute or subacute pulmonary disease (Harrington, 9).

2. Asymptomatic:
   - (*a*) Solitary or multiple cysts with an open bronchial connection; these may only be discovered accidentally.

We present five cases, four of which may be regarded as typical, and the fifth as highly suggestive of this condition.

CASE REPORTS

Case 1. S. A. J., a white male, height, 5 feet 8 inches; weight, 133 pounds; age, 42

years, ambulant, a painter and paperhanger by trade, was admitted to the Veterans' Administration Facility, Memphis, Tennessee, for the treatment of bronchiectasis with air cysts of both lungs. Family history was irrelevant. His personal history was as follows: The patient, besides having had the ordinary diseases of childhood, suffered an attack of pneumonia while with the A. E. F. (air squadron) in France; had an appendectomy in 1917; influenza in 1918, and pneumonia again in 1928. He denied syphilis or neisserian infection. One week prior to admission to the Veterans' Hospital, the patient was bronchoscoped at the Memphis General Hospital, where lipiodol was instilled. On admission, he complained of a hacking cough and shortness of breath, more marked on walking. These symptoms had troubled the patient since 1918 but only lately became aggravated. A physical examination revealed the following: the patient showed moderate dyspnea on slight exercise, with no cyanosis. His head and neck were apparently negative. The chest was asymmetrical; the right hemithorax seemed smaller than the left, with the right shoulder somewhat drooping. Both supraclavicular fossæ, especially the right, were accentuated, and mobility of the chest wall was slightly restricted on the right side. On percussion of the right lung, impaired resonance was elicited at the upper apex and infraclavicular region to the fourth interspace, also impairment of the resonant note from the upper apex to the infrascapular area and at the midaxillary area. Auscultation of the right lung showed: breath sounds suppressed at the upper apex and infraclavicular area to the third interspace, also at the supraspinous fossa; no râles or friction rubs were heard on deep inspiration or coughing. In the left lung the percussion note was normal, the breath sounds were slightly accentuated throughout, and the whispered fremitus was normal. At the lower base on deep inspiration, dry râles were obtained which persisted after coughing. The heart was negative; blood pressure, 125/80. The remainder of the physical examination showed no abnormal findings.

A re-examination of the chest on Feb. 19, 1934, elicited numerous coarse râles through both lower lobes, especially at the bases, where mixed dry and moist râles were encountered which persisted after coughing. These râles were heard on periodic re-examinations. Laboratory findings were as follows: admission roentgenogram showed an area of decreased density corresponding to the right upper and middle lobes, with an apparent absence of lung tissue. Pulmonary markings of the right lower lobe and of the whole left lung appeared normal except that scattered lipiodol was seen at bases of both lungs; the trachea deviated to the right; the diaphragm was smooth, the costophrenic angles clear, and the cardiac and aortic shadows were within normal limits. The sputum was persistently negative for tubercle bacilli. Diagnostic pneumothorax performed on the right side, Jan. 11, 1934, gave an initial reading of minus 4, minus 5.5; 300 c.c. of air was given, and the final reading was minus 0.5, minus 1.5. This procedure was repeated on Jan. 13 and 25, on both occasions resulting in a reduction of the negative intrapleural pressure. A roentgenogram of the chest, taken after the induction of the artificial pneumothorax, outlined the visceral pleura and the compressed intrapulmonary hollow spaces of the right upper and middle lobes.

Clinical course: the patient's temperature, pulse, and respiration stayed within normal limits. His appetite was good, and he gained 25 pounds in weight during his stay in the hospital. It is to be noted that the patient was quite anxious to have pneumothorax treatment continued, stating that his chest felt easier and he was not so short of breath after these air injections —subjective evidence suggestive of a congenital cyst associated with symptoms of mild obstructive emphysema with favorable response to artificial pneumothorax. In the opinion of the attending physician, however, therapeutic pneumothorax was not strictly indicated since the dyspnea

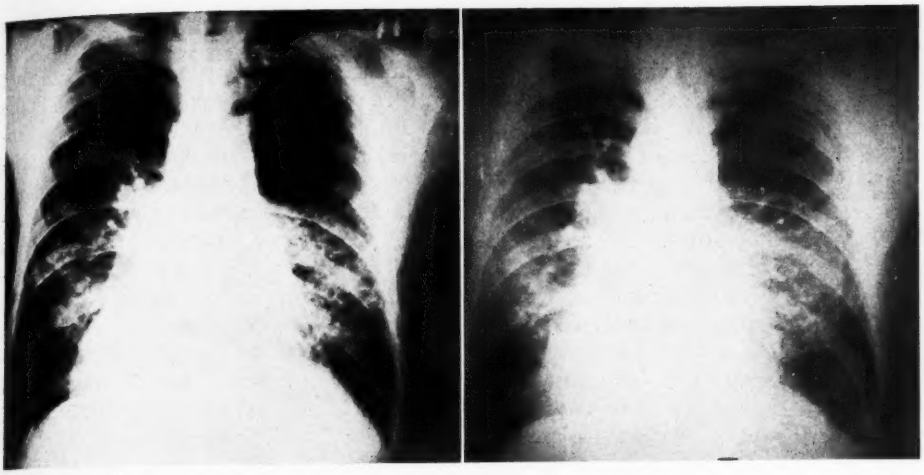

Fig. 1. Case 1 (*left*). Admission film shows the following: an area of decreased density, corresponding to the right upper and a portion of middle lobe with apparent absence of lung tissue; scattered lipiodol at the lower lobes; trachea deviated to the right; diaphragm smooth; costophrenic angles clear, and heart and aortic shadows normal.

Fig. 2. Case 1 (*right*). Chest film subsequent to induction of artificial pneumothorax shows and outlines the visceral pleura and the intrapulmonary hollow spaces of the right upper and middle lobes.

was rather mild in character. The diagnosis was as follows: congenital cyst of right lung (Figs. 1 and 2), with bronchitis, chronic moderate. The patient was discharged as improved on March 25, 1934.

Case 2. L. L., a negro male, 5 feet 11 inches tall, weight 163 pounds, age 53 years, was admitted on July 11, 1934, for the treatment of pneumothorax on the right side, chronic pulmonary tuberculosis, and arterial hypertension. His chief complaints were shortness of breath and wheezing, both of which were more marked at night. There was no history of hemoptysis or loss of weight or night sweats. A physical examination disclosed signs of dyspnea on mild exercise (walking). Chest was symmetrical, with expansion limited on the right side, and palpation was negative. On percussion, resonance was somewhat impaired throughout the right lung while the left lung was apparently normal. On auscultation, the right lung showed diminished breath sounds throughout; whispered fremitus decreased, and obscure dry râles were heard at the midaxillary and infrascapular area. In the left lung, the breath sounds were accentuated throughout, while whispered fremitus was unaltered; occasional dry râles were heard at the lower base. The heart was within normal limits on percussion. On auscultation, the second aortic sound was accentuated; the heart sounds were of good tone, no murmurs being heard. The blood pressure was 210/130. On fluoroscopic examination, the patient showed increased transillumination through the right lung; the left lung seemed normal in appearance. Cardiac and aortic shadows were within normal limits. A roentgenogram of the chest revealed an apparent absence of lung tissue through the right upper and middle lobe with strands instead of the normal pulmonary markings. The left lung seemed negative; heart and aortic shadows normal. Electrocardiogram showed no abnormalities except a deepening of the S-2 and S-3. Patient's temperature, pulse, and respiration were within normal limits. Urinalysis was negative. Blood chemistry showed urea nitrogen 19.6 mg. per 100 c.c. The diagnosis was as follows: hypertension (artery), severe; congenital

air cyst of right lung, and bronchitis, chronic moderate.

Diagnostic pneumothorax was recommended, but the patient refused and he was discharged from the hospital on Aug. 1, 1934. The main point of interest in this case is that we are in possession of the man's records and roentgenograms over a period of seven years. At a previous hospitalization, in 1928, the admission diagnosis of pneumothorax and chronic pulmonary tuberculosis was denied, with the comment that his temperature, pulse, and respiration were normal, and sputum negative. There was an absence of toxemia, no loss of weight and, furthermore, the manometric readings were not those of a pneumothorax. Pulmonary emphysema was suggested. A comparison of the chest films, in 1928, with the recent roentgenograms shows no change, and the absence of lung markings throughout the greater portion of the right lung together with the physical signs indicate congenital cyst of the lung.

Case 3. This case of asymptomatic pulmonary cyst was brought to our attention by a casual chest film. B. H., white male, common laborer, age 42 years, married, with one child living, was admitted to the Veterans' Administration Hospital on Sept. 24, 1932, with complaints of nocturia, frequency of urination, dysuria, and partial deafness. The patient's family history was as follows: his father died at the age of 78 of paralysis; his mother and one sister are living and well. His personal history was irrelevant. There was no history of neisserian or syphilitic infection. A physical examination revealed that his head and neck were essentially negative, except for cholestectoma, bilateral, with marginal perforation of the tympanic membrane. A chest examination showed that there was a slight diminution in resonance of the upper right lobe anteriorly; posteriorly, the resonance was slightly increased in the suprascapular fossa. On auscultation, the breath sounds were diminished, whispered fremitus decreased, while the remainder of the lung examination including the whole left side was negative. Heart sounds were easily differentiated; no murmurs were elicited and the blood pressure was 120/80. The rest of the physical examination—orthopedic, neuropsychiatric, etc.—was unimportant except for positive findings in reference to the genito-urinary tract resulting in a diagnosis of prostatitis (chronic), moderate and seminal vesiculitis (chronic bilateral). Temperature, pulse, and respiration were normal.

Laboratory data were as follows: Wassermann, urinalysis, blood count, and sputum were negative. On admission, the chest film showed an area of decreased density corresponding to the right upper lobe, with apparent absence of lung tissue and only a few curving strands seen at the first and second interspace. The right hilum was increased in size and density, with slight peribronchial thickening at the middle lobe. The left lung was clear. The diaphragm was smooth, the costophrenic angles were clear, heart normal.

A glance at the chest film might suggest spontaneous pneumothorax or cavitation; however, in view of the negative history and the scant clinical findings, the possibility of congenital cyst of the lung was considered. The following procedures (*a* and *b*) were undertaken to substantiate this tentative diagnosis. (*a*) Diagnostic pneumothorax—an attempt at manometric reading, with insertion of pneumothorax needle under novocain anesthesia at the third interspace near the anterior axillary line (right side), was unsuccessful. The needle was reinserted at the second interspace (right side) but no reading was obtained. When the pneumothorax needle was inserted in the fourth interspace (right side, anterior axillary line), the initial reading was minus 1 minus 2; 100 c.c. of air was given, and final reading was 0 plus one-half. (*b*) Lipiodol injection failed to outline the bronchi of the right upper lobe, although caution was taken to have the patient lie on the right side during this injection, the film having been taken in the same position. Roentgeno-

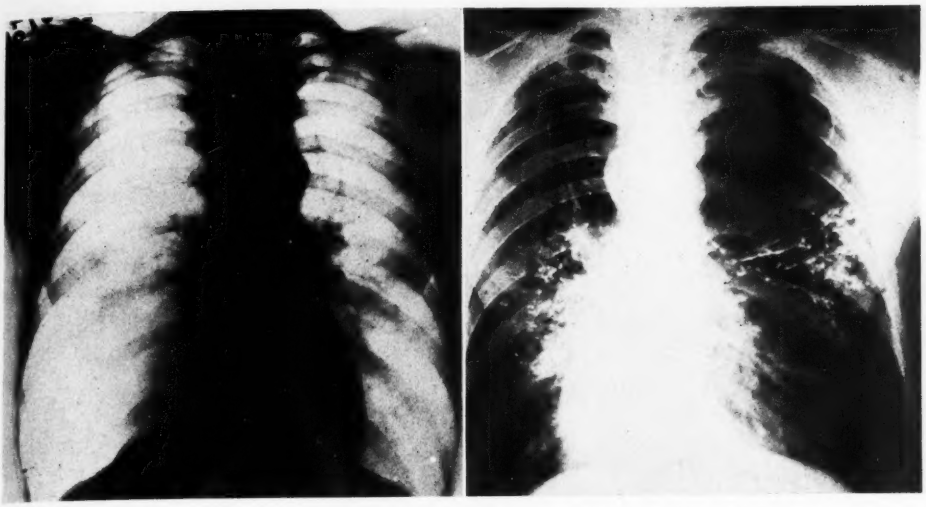

Fig. 3. Case 3 (*left*). Roentgenogram made subsequent to the induction of artificial pneumothorax shows a marked collapse of the middle and lower right lobes, with no apparent effect upon the hollow space in the region of the right upper lobe.

Fig. 4. Case 3 (*right*). Roentgenogram made subsequent to lipiodol injection in accordance with the method advocated by Faulkner and Faulkner fails to outline the upper lobe bronchi, while the bronchi of the right middle lobe are well outlined. Right middle and lower lobes show almost complete re-expansion. Intrapulmonary hollow in the region of right upper lobe remains unchanged.

grams made after injection showed marked collapse of the middle and lower right lobe induced by the artificial pneumothorax, which apparently had no effect upon the hollow space in the region of the right upper lobe (Figs. 3 and 4, Case 3). It is to be noted that the patient, while co-operative, was not enthusiastic about these procedures, maintaining that there was nothing wrong with his chest. He was discharged from the hospital on Nov. 14, 1932, and a check-up chest film prior to discharge showed complete expansion of the right middle and lower lobes with no demonstrable change in the area occupied by the right upper lobe. He was re-admitted to the hospital on March 2, 1933, for the treatment of his prostate trouble, and while undergoing treatment in the G.-U. ward, it was thought advisable to check up the chest findings. Both physical and roentgen examinations showed no change in comparison with those on his previous admission to the hospital. Pleuracentesis on April 21, 1933, with the pneumothorax needle at the second interspace (right side) in the region of the hollow space, gave the following: Initial reading minus 1 minus 3; 150 c.c. of air was given, and the final reading was minus 1 minus 2. The needle *in situ*, connected with a syringe, was inserted deeper and 2.5 c.c. of lipiodol was injected. Subsequent fluoroscopic and roentgenographic examinations showed retention of the lipiodol in the hollow space, delineating adjacent curving strands; there was an induced pneumothorax affecting the middle and lower lobes, while the region of the upper lobe was apparently unaffected. The extent of the induced pneumothorax seemed, as in the former sitting, out of proportion to the amount of air injected; it is possible that the production of a pleuropulmonary fistula accounted for some of the air present, although no untoward symptoms ensued. A roentgenographic examination two weeks later showed retention of the lipiodol at the point of injection and complete disappearance of the induced penumothorax (Fig. 5). This patient was rehospitalized in

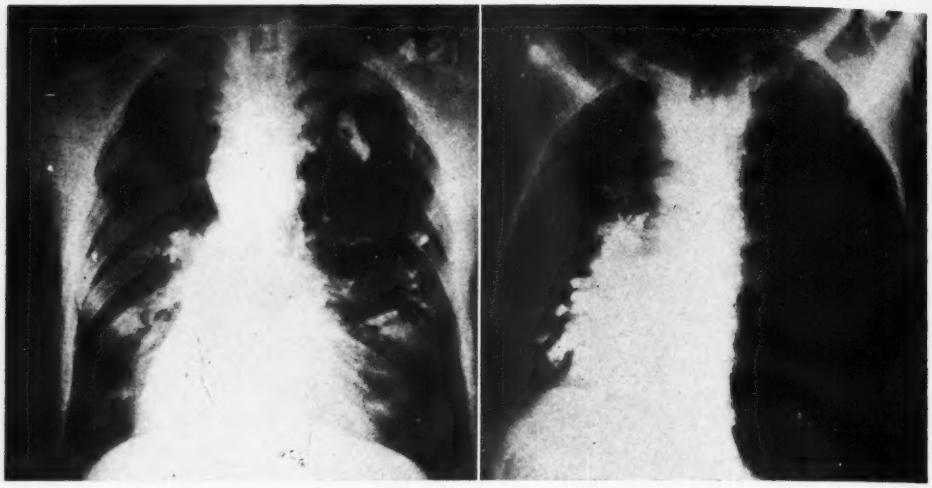

Fig. 5. Case 3 (*left*). Roentgenogram shows retention of the lipiodol at the point of injection in the region of the intrapulmonary hollow and complete re-expansion of right middle and lower lobes.
Fig. 6. Case 5 (*right*). Roentgenogram shows grape-like sacculations in left lung subsequent to lipiodol injection; left lung is reduced in size, left dome of diaphragm is elevated, and the heart and mediastinum are deviated to the left.

January, 1934, for the treatment of purulent otitis media. Physical and x-ray re-examinations of the chest showed the same findings as on the previous admission.

Case 4. This case is similar to the preceding one except that it illustrates the co-existence of two pathologic entities in the same chest which may be confusing. Records show that this man, C. L., on examination in May, 1931, had signs referable to his right upper apex, manifested by impaired resonance and moist râles. In addition, there was a history of loss of weight, cough with some expectoration, and slight evening rise in temperature. On re-examination 12 months later, there was a complete arrest of the tuberculous process at the right upper lobe previously diagnosed as chronic pulmonary tuberculosis, minimal, class A symptoms. However, a recheck of the roentgenogram taken at the first examination with one a year later showed persistence of the area of decreased density at the left upper lobe measuring about 6 cm. in diameter, while the right upper apex presented only a few fibrotic strands. The final diagnosis was chronic pulmonary tuberculosis, apparently arrested, of the right upper lobe; a congenital cyst of the left lung, asymptomatic. The final roentgenogram of the case to all intents and purposes is identical with that of the previous case described except that the location of the air cyst is on the left side.

Case 5. C. F. R., a farmer by occupation, was admitted for examination and observation to the Veterans' Administration Facility, June 7, 1933, with a history of chronic pulmonary tuberculosis. The patient's family history was as follows: his father is living and well; his mother died of acute "indigestion" at the age of 35; three brothers and two sisters are living and well. There was no history of tuberculosis or cancer in the family. His personal history revealed that he had besides the ordinary diseases of childhood, pneumonia at 14, influenza in 1918, 1922, 1928, 1930, chronic pulmonary tuberculosis since 1919, and an appendectomy in 1931. The patient denied any venereal infection. His complaints on admission were: cough, with expectoration especially in the mornings,

shortness of breath, and loss of strength. A physical examination, on general appearances showed that the patient was a well developed, somewhat undernourished white male, height, 5 feet 11 inches, weight, 134 pounds, age, 38 years. He was ambulant and showed no marked dyspnea or cyanosis on mild exercise. His physical examination was negative except for the following positive data: the mobility of the left chest wall was greatly restricted as compared with the right side, which was normal on percussion and auscultation. The left lung presented diminished tactile fremitus and moderately impaired resonance from the upper apex to the lower base which was 2.5 inches higher than the right base; the percussion note at the left lower base showed no change on deep inspiration, while on auscultation of the left lung, the breath sounds were roughened at the infraclavicular area and lower base, whispered fremitus was increased, and occasional dry and moist râles, which disappeared on coughing, were heard at the infrascapular region. The admission roentgenogram showed the left lung to be greatly reduced in size as compared with the right lung which appeared hyperaërated; the left dome of the diaphragm was about three inches higher than the right, the left costophrenic angle was obliterated, and the left lung showed circular areas of lessened density, especially at the lower lobe, which after lipiodol injection appeared like grape sacculations. The heart was deviated to the left. The clinical course was: temperature and respiration were within normal limits, his pulse being 86–90. Laboratory findings showed the following: sputum persistently negative for tubercle bacilli; sedimentation test normal; blood count and Wasserman test negative. An attempt at a manometric reading was made at the fifth interspace midaxillary line on the left side. Some difficulty, however, was encountered in passing the needle through a thickened pleura, and no oscillations of the manometer were obtained, although the procedure was repeated twice (Fig. 6). The diagnosis was as follows: bronchiectasis, congenital(?), with atelectatic effect.

SUMMARY AND DISCUSSION

In the differential diagnosis of congenital cyst of the lung the following conditions were considered:

(*a*) Spontaneous pneumothorax (Cases 1 and 2);

(*b*) Cavitation—involving a whole upper lobe (Cases 3 and 4);

(*c*) Bronchiectasis, acquired (Case 5);

(*a*) *Spontaneous Pneumothorax.*—The following points tend to exclude this: (1) The compressed lung cannot be seen fluoroscopically or roentgenographically. (2) X-ray and physical signs remain unchanged over a long period of time—in Case 2, over six years' observations. (3) Thoracentesis, with lipiodol injection (2.5 c.c.) through the center of the apparently structureless space on subsequent radiographic examination, shows the bulk of the lipiodol retained at the point of injection with only slight scattering accentuating the adjacent curving strands. Had there been a pneumothorax, the lipiodol would have gravitated to the lowest point of the hollow space on assumption of the erect position by the patient. (4) Diagnostic pneumothorax in Case 1 rendered possible subsequent roentgenographic visualization of the visceral pleura (and the compressed intrapulmonary hollow spaces) of the right upper and middle lobes, thus excluding spontaneous pneumothorax. In Case 3, diagnostic pneumothorax failed when the pneumothorax needle was inserted into the second and third interspaces (anterior axillary line); it was successful, however, at the fourth interspace (midaxillary line) and at the center of the apparently hollow space. As shown by the films (Figs. 3, 4, and 5), the induced pneumothorax affected the middle and lower lobes, while the region of the upper lobe remained unchanged. This finding apparently indicates an obliter-

ated pleural space in the region of the right upper lobe, and, of course, rules out a diagnosis of localized pneumothorax. The case reported by Hermes and Mumme (13) showed that at autopsy, "the whole right upper lobe is attached to the chest wall by adhesions. Its parenchyma is occupied by a system of multiple cavities or cysts varying in size, etc." In such a case it would evidently be impossible to outline the visceral pleura of the right upper lobe by an induced pneumothorax. Similar pathology, it is believed, exists in Case 3, described above.

(*b*) *Cavitation.*—When the clinical findings in Cases 3 and 4 are considered together with the roentgenograms, it becomes evident, as in the cases reported by Siems (10), that the intrapulmonary hollow spaces are not cavities due to the processes of disintegration.

(*c*) *Bronchiectasis, Acquired.*—The history of chronic pulmonary tuberculosis in Case 5 and perhaps the presence of an obliterative pleurisy on the bronchiectatic (atelectatic) side might suggest the acquired form. There is, however, one fact about this case which points to a probable congenital origin, *i.e.*, that lipiodol injection in the left lung failed to outline the small bronchi of the lower lobe and those of the peripheral zone. The appearance of this lung after bronchography suggests bronchial maldevelopment rather than bronchiectasis. Furthermore, in Case 3, although care was taken to have the patient lie flat on the right side during the injection in accordance with the method advocated by Faulkner and Faulkner (11) bronchography failed to outline the right upper lobe bronchus. This and the lack of outline in the lower lobe bronchi in Case 5 would seem to support the opinion of Wolman (12) that these cystically dilated bronchi and alveoli (due to congenital maldevelopment) form a closed system or systems wholly or partially discontinuous with the main bronchi.

I wish to express my appreciation to Dr. Philip B. Matz, Chief Research Subdivision, Central Office, Washington, D. C., for his helpful criticism of this paper.

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DISCUSSION OF PAPERS IN SYMPOSIUM ON THORACIC NEOPLASMS

DR. LEO G. RIGLER (Minneapolis): There has been so much presented here that it is very difficult to confine oneself to the few things that the remaining time permits. I do want to make a few comments on some material that perhaps has not been emphasized as much as it might be.

First is the question of cysts of the lung. When we see a patient come in without any previous history, with or without symptoms, presenting a cavity in the lung, the tendency is to call it a congenital cyst. This is not entirely justified, however, because there is such a thing as an acquired cyst of the lung, which might be the case in any of these, and I have a few cases just to illustrate that point.

The first one (Fig. 1) is a young child who,

I think we can say definitely, has a congenital cyst of the lung. This child had symptoms at birth which were interpreted as being due to congenital atelectasis or possibly an enlarged thymus. A roentgen examination at that time showed it was not, the mediastinum being displaced to the other side, if anything, and the suggestion that there was fluid of a rather peculiar character was made at that time (Fig. 1-*A*). Aspiration was done a week or two later and air replaced in the pleural cavity, which demonstrated this peculiar cystic appearance in the lung itself (Fig. 1-*B*).

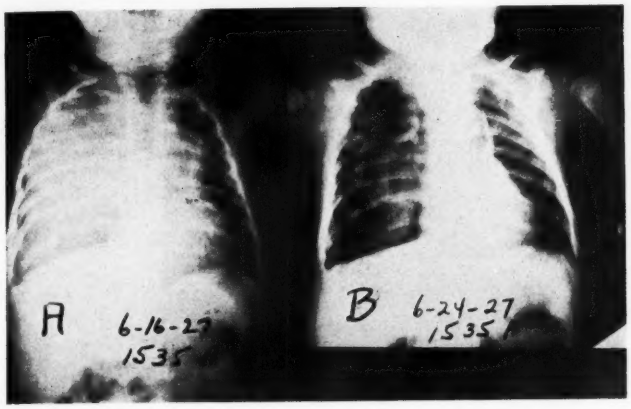

Fig. 1. Case of true congenital cyst of lung. *A* shows fluid in right hemithorax; *B* shows replacement of fluid with air.

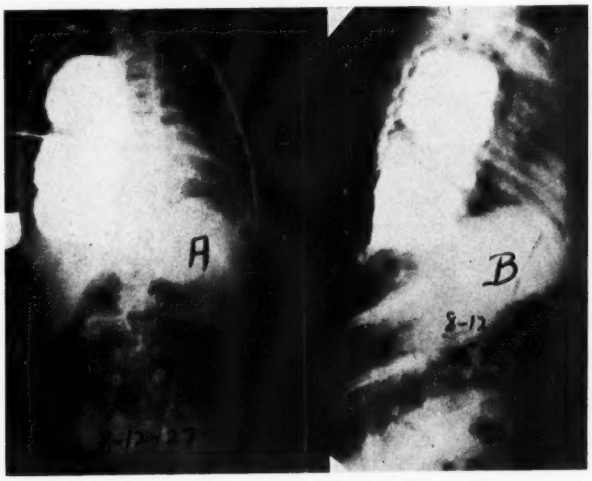

Fig. 2. Same case as shown in Figure 1. *A* shows injection of opaque medium into right lung cyst; *B* shows lateral view. Note outline of lobes and clear separation from thoracic wall.

We later injected opaque medium directly into the lung. You can see here (Fig. 2) the formation of the lobes, indicating that the opaque medium went into the lung itself, and demonstrating clearly that we were dealing with a congenital cyst. This child was operated upon, got along very well, but, following a bronchoscopy to

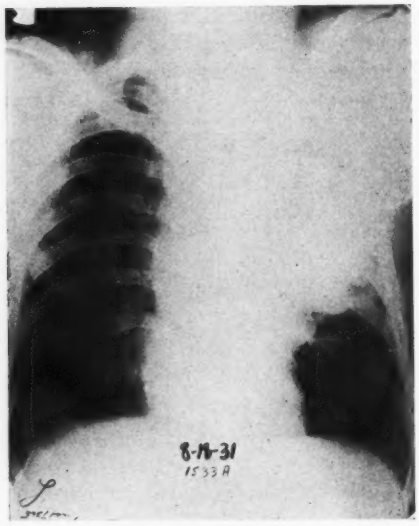

Fig. 3. Case of acquired lung cyst. First examination showing extensive pneumonia. left upper lobe with beginning cavitation.

demonstrate that it was a bronchogenic cyst, for no apparently adequate reason the child died.

tion very early in the course of the disease, and had staphylococci in the sputum. In many of these cases staphylococci are also found in the blood stream.

Here is the same patient (Fig. 4) a short time later and you see the development of these large cavities. Here is a lateral view (Fig. 4-*B*) and this very large cavity here, well made out, with the fluid level in it. When we saw the same patient, still some time later, there was a little re-accumulation of fluid, a small lesion on the right side also; then here it is (Fig. 5) about six weeks from the onset of the illness—a large lesion on the right side and that on the left beginning to resolve and showing a large cavity above.

Here is the same patient the following year (Fig. 6-*A*), with this very large cavity in the upper lobe. This appears to be quite typical of the appearance we see in these patients who present themselves with a cavity, which apparently arose out of a clear sky or in which no particular previous illness can be assigned. He was given io-

Fig. 4. Same case as shown in Figure 3, two weeks later. *A* shows postero-anterior view with large cavities and beginning consolidation in right upper lobe; *B* shows lateral view, with fluid levels in cavities.

Here is another type of case entirely (Fig. 3). This man came in with what Dr. Reimann, who does most of our work on pneumonia, calls a staphylococcic pneumonia. Some people might prefer to call it acute, multiple lung abscesses. He had symptoms of pneumonia, developed cavita-

dized oil, which failed to enter into the cavity but did enter the lower bronchus.

This is the same patient several years later, the film made early this year (Fig. 6-*B*). He is entirely symptomless, has no physical findings, but he has still this large cavity in the upper lobe without any

evidence of lung markings within it at all. It is very similar in appearance to those cases that Dr. Dubrow showed and yet

Fig. 5. Same case as shown in Figures 3 and 4, one month later, showing development of consolidation in right upper lobe with improvement in left upper.

undoubtedly in this case this is an acquired cyst. There is no further fluid in there. He has no sputum or anything of the kind. He has some type of cavitation in the lung which arose as a result of this inflammatory process in the first place.

So I think we should confine our term to cystic disease of the lung, a fair term to use; in those cases in which we are certain it is congenital, we can call it that, and in other cases in which we are certain it is acquired, we can call it that, and in those in which we are not certain, perhaps we should leave the terminology to the future.

I just want to say a word or two about the primary tumors of the lung. We have obtained a great deal of assistance from the use of iodized oil. We give it ourselves by the passive method. In our hospital, at least, bronchoscopy has not produced the brilliant results reported in Philadelphia, so that the iodized oil examination has been a very helpful thing in making certain the diagnosis of this condition which is certainly very difficult to be sure about.

I want to show one film which demonstrates very beautifully the virtue of this examination. This was made under the roentgenoscope by Dr. John Eneboe, one of my former assistants, who had given the iodized oil, gotten it into the bronchus and then secured this film (Fig. 7) before it was expelled, showing the typical filling defect in the bronchus which is so characteristic.

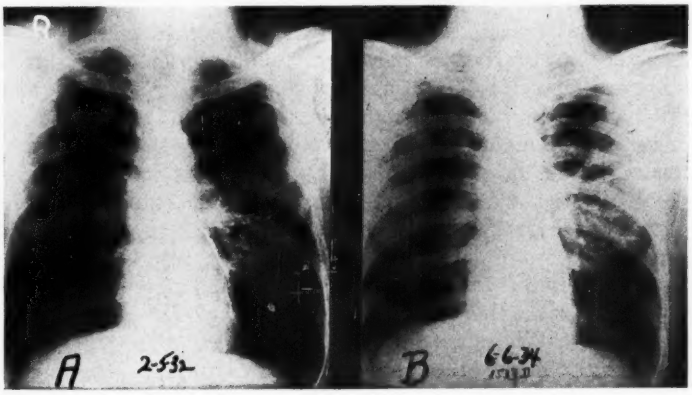

Fig. 6. Same case as shown in Figures 3–5, showing development of lung cyst. *A*, postero-anterior view, with iodized oil, six months after acute condition. Note large cavity without fluid in left upper lobe. Iodized oil did not enter into cavity. *B*, similar condition two years later with patient entirely symptom-free.

We also, of course, have demonstrated complete obstruction in some cases and in other cases, in which the tumor was of markedly peripheral origin, the absence of

any involvement of the primary larger bronchi.

Just one more word about metastasis.

Fig. 7. Bronchogenic carcinoma of right upper lobe bronchus. Defect in bronchus demonstrated by iodized oil.

Our experience has been very different from that of Dr. Farrell in the site of origin of the metastases. We very rarely see a metastasis to the lungs from the gastro-intestinal tract; very rarely from the prostate. I have not any figures so that I can not quote this accurately, but I have a clear-cut impression that metastases from the gastro-intestinal tract or prostate are relatively rare in the lungs, while of course we do see a great many from the breast and various other organs.

It has been our experience that the appearance of metastases in the lung, especially the nodular type, is more pathognomonic than almost any other lung lesion. We are certainly in error occasionally in describing definitely a tuberculosis or a pneumonia or whatnot in the lungs. That is, we are in error as to the exact etiology of the condition, but it is very rare that one is in error, when a typical metastasis appears, in describing it.

We do see a few rare cases of what the Germans called the *rund herde* or round focus type of tuberculosis, which simulates metastasis very closely. In those cases some error might occur. Otherwise, it has always seemed to me that there is hardly anything more characteristic than the roentgen appearance of pulmonary metastasis.

DR. WILLIAM E. ANSPACH (Chicago): I just want to say a few words about the early development of some of the cyst-like cavities that are seen in chest roentgenograms.

It seems to me that it is unwarranted to assume that a solitary or cluster of air-containing cavities with symptoms dating back to infancy, such as Dr. Dubrow has shown, are of congenital origin. It has been my privilege to observe quite a number of proved congenital cysts in young children. These were fluid-containing at first and later formed a communication with a bronchus, after which the fluid was replaced by air. Large air cysts tend to trap air, balloon out, and in this manner produce suffocation by compression of functioning lung tissue. Adolescence is rarely attained.

A similar attitude should be taken regarding bronchiectasis. I have been able to follow quite a large group of children through serial roentgenograms and autopsies, from infancy to beyond puberty, and have noted that the development of bronchiectasis occurred in dependent, persisting atelectatic portions of the lung.

These facts support the theory that the majority of cyst-like air cavities in adults are acquired after birth and are not of congenital origin.

DR. DUBROW (closing): I am very pleased to see the paper provoked discussion, some adverse and some favorable.

I want to say this much, however, that while we think these cysts are congenital, we could be positive only if we had films of these patients from early infancy. However, these shadows of decreased density demonstrated on the slides, if thought of as acquired in character, should properly be classified as cavities, emphysematous blebs

or bullæ—hardly probable when all clinical data are concerned.

Roentgenographically, it is possible for an emphysematous bleb or bulla (from a previous infection and adhesions) to simulate a cyst, but the case presented by Dr. Rigler, judging from the history and the physical findings, suggests cavitation. It is possible to differentiate between a cavity and a cyst by thoracentesis and lipiodol injection through the apparently structureless space. While in a cavity the lipiodol will gravitate downward, in a cyst with its honeycomb structure, the lipiodol will stick at the point of injection, as demonstrated in one of the cases. I do think that it is perhaps preferable to use the term "polycystic disease" or "cystic changes of the lungs" without much emphasis on the word "congenital."

CASE REPORT

CARCINOMA OF THE STOMACH IN A GIRL 21 YEARS OF AGE[1]

By W. JAMES MacFARLAND, M.D.,
Hornell, New York[2]

The patient, M. M., aged 21 years, first consulted her physician in April, 1933, for a stomach upset with vomiting, which she ascribed to something she had eaten. He found nothing unusual on physical examination and gave her cerium oxalate and antacid, asking her to return for further examination. She called him a few days later saying that she was completely recovered.

On Oct. 25, 1933, she called her physician again, complaining of continuous vomiting which she had had for one week, at times containing food she had eaten two days before, and also gas and cramplike pains in the upper abdomen. Her past history showed that she had always had stomach trouble and she was described as "picking" at her food rather than eating it. Her mother had died of a probable cancer of the stomach; the remainder of the family were alive and well.

Physically, she was a small, thin girl, somewhat undernourished, with a dry tongue. On palpation, there was found a tender mass in the epigastrium in about the position of the stomach, the size being reduced by gastric lavage, and a large amount of undigested food and fluid was obtained.

An x-ray examination the following morning showed the stomach to fill with poor tone and without any waves being seen. The meal stayed entirely on the left side of the abdomen, with a sharp tapered end in place of the usual antral shadow. Pressure on the media, in the manner used to fill the cap, caused a small amount of barium to shoot through a narrow canal and then outline the sphincter and duodenal cap. None of the barium remained in the canal. A mass was then palpated in the filling defect, which was movable and moved with the stomach (Figs. 1 and 2). At six hours, there was a large residue with similar findings (Fig. 3). At 24 hours, there was still a residue but the patient had vomited.

The patient was operated upon on October 29. A large infiltrating mass was found to occupy the lower third of the stomach, par-

Fig. 1. A postero-anterior film of the stomach.

Fig. 2. An oblique view of the stomach.

[1]The pathologic examination is from the New York State Institute for the Study of Malignant Disease, at Buffalo, N. Y.

[2]I am deeply indebted to the attending physician, Dr. A. J. Karl, for his help in preparing this case.

ticularly the greater curvature. A partial gastric resection with closure of the duodenum and posterior gastro-enterostomy was done. A transfusion was given and the patient was returned to her bed with a permanent venoclysis running into the leg. The post-operative course was uneventful until the fourth day, when a phlebitis appeared at the site of the venoclysis. The cannula was removed and the patient began to take fluids by mouth. Early in the morning of the eighth day, she was seized with a sudden sharp pain in the lower left chest, made a violent outcry, and sat up, becoming pulseless, cyanosed, cold, and clammy for an hour. On recovery, she complained of crampy pain in the lower abdomen, and an x-ray of the chest and abdomen showed some hazing in the lower left lung, with air beneath the left diaphragm. There was no evidence of infarct. Her temperature rose steadily, and she died 21 hours later—on the morning of her twenty-second birthday. An abdominal autopsy showed a rupture of the resection incision at the lesser curvature.

The pathologic report on the resected stomach was carcinoma of the small round-cell type. There was infiltration of all the coats of the stomach.

This case is interesting not only for the presence of cancer in a very young woman but for the unfortunate surgical accident when recovery was good and apparently assured. It is to be regretted that autopsy of the chest was denied. This would have determined whether a lung infarct was present, as contended by some who saw the case.

Fig. 3. A six-hour film.

EDITORIAL

LEON J. MENVILLE, M.D., *Editor* HOWARD P. DOUB, M.D., *Associate Editor*

SHALL WE TELL A CANCER PATIENT THE TRUTH?[1]

The beauty and perfection of truth are so integral with life that he who propounds a deviation from it assumes the burden of proof as to the right therefor. The crassness of deception in the field of cancer diagnosis can hardly be alleviated by considering the pain to relatives, the difficulty in brooking the emotional upset to the patient at the time of telling, or the fact that by making so definite a diagnosis the physician has lost the protection to himself of equivocation—none of these reasons, which, I believe, are the cause of much deception—may be considered.

The duties of the physician are relatively clear. First and foremost in American civilization comes his duty to the patient (there are, of course, exceptions in the case of minors). Second, he owes many duties to the State. This is more particularly true in the fields of public health, etc., and need not concern us here. Far to the rear of these concepts follow what other considerations there are.

If we admit the pre-eminence of the patient's health, we have simplified matters a great deal. We must simply ask ourselves and then carefully consider, "Will this patient's recovery and mental health be improved or retarded by knowing that he has cancer?"

These patients readily fall into two groups, those who may be curable and those who are not.

A specialist in cancer usually knows even after a cursory examination the site of origin of a neoplasm, and he knows or should know what percentage of these various types may be cured by radium, by x-ray, or by surgery. If he is at all honest he wishes to apply that therapy most likely to lead to a cure. All these instrumentalities are expensive and in many cases all three of them must be used. Almost every patient, without exception, is willing to sacrifice his material possessions if he can increase his chance of living as much as 1 per cent. Do we have the right to deny him not only the truth but also a full knowledge of these other facts which may aid him to determine his course? There is only one answer —No!

But, you may say, the patient may take all this treatment without such suasion. Perhaps. How can one know in advance? If he "bucks" a little at some stage of the treatment and then you have to confess the truth, have you not lost his confidence?

But, the relatives plead, he may commit suicide. He will not! There are few who cling to life as do the cancer patients, if they, in fact, believe there is hope for cure. The danger of their losing this precious possession only increases the desire to cling to it, in early stages when they still possess full mental powers. They will worry, yes, but it is very doubtful whether that worry is more intense when the truth is known to them than it is in the cases of those pitiful individuals who suspect, but who are repeatedly assured to the contrary. The scales and the mirror at least are honest.

THE INCURABLE

Here the problem is more difficult. In the advanced case which is approaching a moribund state, the deception is not too important as regards the patient. Will Rogers, in his portrayal of "Old Doc Bull," speaks words of truth when he says something like this, "I have seen, I guess, three or four hundred people die, and none of them minded. They were too sick!" The critical faculties are blessedly anesthetized when this stage is reached. However, between these extremes there is a vast group of cases which tries the nerves and souls of all concerned: those patients whose neoplasms are slowly growing, but have metastasized or lie in inaccessible regions. Here, often the patients do fret and at times undergo mental agony. Yet is this agony any worse for those who know than for those who do not? Until finer means than we now possess are devised to measure quantitatively the mental states, we can have no certain answer. However, as one who has seen his share of these cases, I presume to conclude that in my own experience they do not.

[1]For previous discussions of this subject, see RADIOLOGY, December, 1934, **23**, 751; also February, 1935, **24**, 247.

For eight months I was associated with the cancer department of a great Jewish hospital. I was told that these emotional persons were difficult to handle and had best not be told the truth. So far as I could discern this was not true. They were, of course, quite intelligent and equally co-operative, whether they were aware of their actual conditions or not.

What is the legal side of the question? I do not know of any statutory or other legal duty to inform the patient of the proper diagnosis, but I am sure that in many States we are forbidden to tell others of the patient's condition, and, should that diagnosis be wrong, we would be liable for damages. Relatives are "others," in that sense. In other words, we are required to exert only due care in making a diagnosis, but we are absolutely liable when we erroneously inform others of a diagnosis and the patient is injured thereby (Griffin *vs.* Wilkin, Ohio St. Med. Jour., Feb. 1, 1931, **27,** 157). Furthermore, medical ethics demand that we keep the patient's confidences. By what right do we physicians ignore these plain mandates of medical ethics and the law? I do not know.

Perhaps the greatest single obstacle that we meet in applying adequate therapy is the plain and stubborn belief that cancer is incurable. This is furthered by the fact that the diagnosis is rarely exposed until the patient is dead or dying. Even those who have been cured a decade before are prone to conceal the fact. Success in treating cancer, like success in any other field of endeavor, is its own best advertisement. Let us encourage these persons to be living advertisements for advanced medical thought.

Let us analyze these reasons for deceiving the patient. First, the matter of suicide. I stated above that I consider this no more likely than in any other morbid condition, if the patient really has hope. But suppose his condition is hopeless; suppose he has but a few more months to live, in agony, and is a source of discomfort in sight and odor to those about him. What right do I have to prevent that solution by concealing the truth? It would seem to be a rational and sane solution in many cases.

The relatives say that treatment will not do any good—the poor fellow will die anyway. Are they to judge, or is the doctor and the patient? Sometimes the impression is unmistakable that what the relatives mean is that treatment is a waste of money which will otherwise go to them.

And now to the last reason, one not so often expressed but nevertheless operative, particularly in the case of the general practitioner. To diagnose cancer is to commit oneself with certainty to a course of treatment, and if the doctor is wrong quite a few people will know of it. He does not have the opportunity to hedge as in the case, let us say, of lobar pneumonia, so diagnosed, that gets well in two days; in cancer he has committed himself to a course of action. Secondly, his feelings protest against the traumatisms to his own psyche when he and the victim have common knowledge of the disease. He is a coward fleeing from his emotion and that of his patients. These two arguments need not be refuted; merely to drag them into the sunlight dissipates them.

CONCLUSIONS

The question, "Shall we tell cancer patients the truth?" is answered by the statement that the physician's first duty is to his patient. Legal duty and medical ethics demand that he be faithful to this concept alone. No evidence can be produced, nor arguments adduced, that deceit contributes to the patient's welfare. On the contrary, reason and experience indicate that here, as elsewhere in human endeavor, honesty is a practicable policy.

FRANK A. RIEBEL, M.D.
Columbus, Ohio

COMMUNICATIONS

RADIATION THERAPY

AT MICHAEL REESE HOSPITAL AND EDWARD HINES HOSPITAL

As occasion may offer, the Editor of RADIOLOGY proposes to visit hospitals and clinics and to publish reports on activities having to do with the use of the x-ray and radium in the treatment of malignant disease. The first sketch is that of the Michael Reese Hospital and the Edward Hines Hospital, Chicago. The idea is to acquaint radiologists with exactly what is being done in regard to the use of the x-ray and radium, from personal observation and experience.

Dr. Max Cutler, Director of the Tumor Clinic of the above-named hospitals, gave the Editor the following facts upon the occasion of his visit.

Michael Reese Tumor Clinic department was organized three and one-half years ago. At the present time, there is a full-time staff consisting of the following personnel: Director, first assistant, research assistant, resident and assistant resident, physicist (part time), four secretaries, nurse, three radium nurse-technicians, photographer, artist (part time). This makes fourteen full-time workers and two part-time workers.

The radium equipment consists of 500 milligrams of radium element in platinum needles and tubes: One radium pack holding four grams and one holding two grams. The total amount of radium available is six and one-half grams.

Recent developments in the department consist in the establishment of a laboratory of tumor pathology, a physics department, and an experimental research department.

The radium packs are utilized according to the Coutard principle. Patients who suffer from carcinoma of the mouth, tonsil, pharynx, larynx, or breast are treated twice daily and consecutively over periods varying between twenty and sixty days. The treatment is continued until the characteristic reactions of the skin and mucous membrane described by Regaud and Coutard are reached.

Carcinoma of the mucous membrane of the mouth, with the exception of the tongue and the cheek, are treated by a newly devised technic in which vulcanized moulds are fitted for each individual case. These moulds permit an absolutely accurate application which can extend over a period of days.

Carcinoma of the cervix is treated by means of the colpostat and a cervical applicator. Carcinoma of the breast is treated by a combination of surgery and radium. A selected group of operable carcinomas have been treated by interstitial radiation alone.

The bed capacity of the Edward Hines Hospital tumor division exceeds that of any other institution in this country or abroad. It now numbers approximately three hundred beds. Patients are sent to this unit from all the United States and referred to this unit by the other Veterans' Hospitals.

The manager is Dr. Hugh Scott, who originally segregated the carcinoma patients from the other patients in the Hines Hospital and recognized that they present a special problem in diagnosis and treatment. It is the present plan of the Medical Director, Dr. Charles M. Griffith, to organize and equip several other subsidiary units for the treatment of tumors.

The Tumor Department is well equipped with x-rays and radium. The emanation plant contains one gram of radium. The radium bomb contains two grams of radium. This bomb was constructed with mercury protection instead of lead and is similar to the four-gram apparatus used in the Tumor Clinic of the Michael Reese Hospital.

There are two deep therapy x-ray machines, 200 K.V. each. X-ray therapy is administered according to the Coutard principle. The radium bomb is used principally in carcinoma of the larynx, pharynx, and tonsil by the divided dose method.

Radium emanation is used in the form of 0.3 mm. gold seeds in the treatment of certain lesions. The seeds are inserted in removable steel needles so that the total filtration is equivalent approximately to 0.4 mm. platinum.

The large bed capacity permits prolonged observation of patients during and after treatment.

A research unit has been installed by the Veterans' Bureau as part of the tumor division. This unit consists of an experimental research worker, a statistician, a photographer, and a secretary.

A comprehensive and efficient system of follow-up is enabled by this unit. Through the records in the central office of the Veterans' Bureau in Washington, the ultimate condition of every patient is known, so that the final follow-up is 100 per cent. This central control is of great assistance in this study of tumor cases.

INDIANA ROENTGEN SOCIETY

The eighth annual meeting of the Indiana Roentgen Society was held at the Indianapolis Athletic Club on February 22. Dr. B. H. Nichols, of the Cleveland Clinic, Cleveland, Ohio, addressed the Society, and the following officers were elected:

President, D. C. McClelland, M.D., Lafayette; *President-elect,* E. M. Van Buskirk, M.D., Fort Wayne; *Vice-President,* P. D. Moore, M.D., Muncie; *Secretary-Treasurer,* J. N. Collins, M.D., Indianapolis.

THE CONTRIBUTIONS TO RADIOLOGY OF PROFESSOR WILLIAM DUANE

By GEORGE L. CLARK, University of Illinois, *Urbana*

In the death on March 7, 1935, of Dr. William Duane, Professor Emeritus of Biophysics at Harvard University, the science of radiology has lost possibly its greatest pioneer experimenter. As a physicist he played a leading rôle for twenty-five years in establishing the fundamental principles upon which the medical science of x-ray and radium therapy has been built. Without the products of his ingenious applications of physical laws of radiation to the scientific treatment of cancer, radiology would now be far less advanced. With the death of Professor Duane at the too-early age of 63, following several years of declining health, there were left uncompleted scores of further contributions in this, his beloved field of research.

William Duane, a direct descendant of Benjamin Franklin, was born in Philadelphia on February 17, 1872, and was graduated from the University of Pennsylvania in 1892. The following year he received a Bachelor of Arts degree at Harvard University and in 1895 a Master of Arts degree. As holder of the Tyndall fellowship of the University of Pennsylvania he studied in Germany at the Universities of Berlin and Goettingen and received the degree of Doctor of Philosophy from the former in 1897. He served then as Professor of Physics at the University of Colorado from 1898 to 1907, when he was invited by Pierre and Marie Curie to come to Paris and join them in radium research. He spent five great years in this laboratory. The impression which he created is illustrated by the following incident. On a visit to this country a few years ago Madame Curie was asked what places she would like most to see. Along with Niagara Falls she placed the laboratory of Professor Duane, at Harvard University, to which he came in 1913. In 1917 the chair of Biophysics was created by Harvard for him so that he could combine physics with applications in medicine and biology. He divided his time between the Jefferson Physical Laboratory and the Huntington Memorial Hospital under the direction of the Cancer Commission of the University, continuing immeasurably great work in both capacities until ill health forced him to retire in 1934.

The work of Dr. Duane has been widely recognized by presentation of honorary degrees, medals and prizes, and membership in great honorary societies in this country and abroad. One of the elements of a great personality, as always, was his great modesty and intense devotion to the highest ethics of science, which may have served to limit an even wider, though less enduring, acclaim. He was content to let his work speak for itself—and to those who know its value it shall remain through all time as a brilliant page in scientific achievement.

It is of interest to attempt to list a few of the outstanding contributions made by Professor Duane to radiology. The following list is by no means exhaustive but simply illustrative. Numerous radiologists will be surprised that many of the great fundamental principles employed daily as a matter of course in a rational modern use of radiation in the treatment of cancer, rest upon the original investigations of Professor Duane, who strove to remove all uncertainties and guesswork in the use of these rays.

1. Design and construction of a successful automatic apparatus for drawing off radon gas from a permanent radium supply into seeds for therapeutic use.

2. Design and first use in cancer therapy of a constant potential, high voltage, x-ray power plant utilizing high frequency (500 to 2,000) generators, condensers, etc.

3. Design and use of 100,000-volt storage battery at Harvard University in establishing laws upon the basis of absolutely constant voltage.

4. Improvement in design and first use of the ionization spectrometer less than a year after the original apparatus of the Braggs, leading to the long series of studies on x-ray wave lengths.

5. The first scientific study of general or "white" radiation, and the correlation of intensity with atomic number of the target element.

6. Discovery of the law of Duane and Hunt, that the short wave length limit (λ_0) of the general radiation spectrum is governed by the quantum law $Ve = h\nu_0 = hc/\lambda_0$.

7. The first accurate measurement from the above law of the value of the Planck action constant, h.

8. The first accurate evaluation of wave lengths in the K and L series of tungsten (used in all medical tubes as target) through as many as five orders of reflection. These 1914 values

remain to this day very close to the present accepted values.

9. The first quantitative study of critical absorption wave lengths from many elements, following soon after the discovery of the Moseley Law, and the first demonstration of departures from that law as a linear one.

10. Proof of the identity in value of the characteristic ionization, characteristic absorption and the "quantum" wave lengths. The last is the value which must be excited in $Ve = hc/\lambda$, so that the emission lines will appear. These values were shown to be $^1/_4$ or $^1/_3$ per cent shorter than the value of the shortest characteristic emission line in a given series.

11. The first quantitative measurements of the absorption coefficients for copper and aluminum, used as filters in x-ray therapy:

$$\text{Al}, \mu/\rho = 15.5\ \lambda^3 = 0.147$$
$$\text{Cu}, \mu/\rho = 193\ \lambda^3 = 0.13$$

12. The original definition of "effective wave length" for a heterogeneous x-ray beam having the same absorption as some monochromatic ray, and the establishment of the standard absorption curves from which this is determined and defined for dosage.

13. The first design and practical use in America of an air ionization chamber, standardized in terms of e. s. u., upon which in part is based modern intensity measurements in r units.

14. The first therapeutic use of thorium and uranium target x-ray tubes.

15. First measurements of x-ray spectra from aluminum target tubes.

16. The discovery three years ago of characteristic emission lines shorter than $K\gamma$, due to O or conductivity electrons falling into the K energy level in the atom.

17. The study of the general radiation spectrum from an extremely thin target (stream of mercury) and demonstration that a spectrum approaching a single wave length is produced.

18. Numerous contributions to the knowledge of scattering of x-rays by containing walls, water phantoms, etc.

19. Mathematical proof of transfer in quanta of radiation momentum to matter, as a preliminary step to development of modern wave mechanics.

20. The first successful adaptation of Fourier series analysis of intensities and electron distributions following a suggestion by Sir William Bragg, upon the basis of which great progress has been made in analysis from x-ray data of atomic, molecular, and crystalline structures.

It is impossible to conclude this brief sketch without a personal note. The writer had the great privilege of working with Professor Duane for three years and came to know well not only the extraordinary scientific ability but the remarkable personality which left its indelible impress forever on the fortunate few who came into intimate contact with it. Quiet, modest, kindly, and considerate, he personified the ideal combination of man of science, home-lover, teacher, and friend. He derived his greatest joy in working on experiments with his students. His influence was radiated not so much in words, which were few, but in living and doing things just as well as it was humanly possible to do them. In appreciation of his inspiration and guidance which changed the course of a lifetime, this writer mentioned him in a phrase in the preface to a book on x-rays which somehow expresses the facts perfectly. Though he worked with invisible rays, and though the touch of a personality was invisible, William Duane was a Maker of Light.

HOW LONG ARE WE LIABLE?

PHYSICIAN SUED FOR ALLEGED FLUOROSCOPIC BURN AFTER SIXTEEN YEARS!

It has come to the writer's notice that a physician in a mid-western State has recently been sued for malpractice, *based upon surgical services rendered by him in 1918.*

The defendant physician removed a needle from the leg of a six-year-old boy sixteen years ago, and the plaintiff now alleges that a roentgen dermatitis resulting from the use of the fluoroscope, while searching for the needle, during the operation, permanently and seriously damaged him.

The statute of limitation for this sort of action places two years as the period within which suit may be brought, in the State wherein this suit is pending; but because the plaintiff in this case was a minor at the time of the alleged injury, the statute of limitation did not begin to run (or, as the legal profession say, was *tolled*) until he, the plaintiff, became of age. Consequently, the limitation as prescribed by the statute, did not expire until two years after

the age of twenty-one had been attained by the, at that time, six-year-old boy.

While the foregoing is only the logical result of an ordinary and not very unusual event, it is of sufficiently infrequent occurrence to cause us to "sit up and take notice," and should be another timely warning that "eternal vigilance is the price of liberty." The writer wonders how many who read this would have records of the length of time, the voltage, F.S.D. or other important particulars of this exposure, *after sixteen years*.

I. S. TROSTLER, M.D.

ITALIAN CONGRESS OF RADIOLOGY

The subject of the next Italian Congress of Radiology will be Diagnosis and Treatment of Pharyngo-esophageal Tumors, with Invasion of the Base of the Skull.

In order not to miss any American contributions, the undersigned would appreciate reprints of any papers appearing in the United States on this subject.

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BOOK REVIEWS

RADIOLOGIE CLINIQUE DU TUBE DIGESTIF: I.—ESTOMAC ET DUODENUM. By PIERRE DUVAL, JEAN CHARLES ROUX, and HENRI BÉCLÈRE. In two volumes: (I) The Stomach, (II) The Duodenum. Second edition, qŭarto, 374 pages, 514 reproductions of roentgenograms, 516 drawings. Cloth. Published by Masson et Cie, Paris, 1935. Price: 330 francs.

Representing the joint efforts of an eminent surgeon, a distinguished gastro-enterologist, and the Nestor of French radiologists, this work could not fail to be a strikingly valuable contribution to the clinical radiology of the alimentary canal. The general esteem accorded to it is shown by the fact that the first edition, published seven years ago, was sold out within eighteen months, and this alone would be sufficient reason for a second issue. Aside from this consideration, however, the authors have rightly felt that a new edition is warranted by advances in gastro-intestinal radiology in recent years. Outstanding among such advances has been the intensified study of the mucosal relief, and in the present issue especial attention has been given to this feature. Thus, as the publishers say, although the second edition is the same as the first, in conception and basis, it is also an entirely different work. Primarily it is an unusually complete and systematic roentgenographic atlas, whose illustrations are clarified by accompanying drawings, but, in addition, each subject is formally discussed in concise but ample text.

Following a pictorial and textual presentation of the normal stomach with its variants, anomalies, and functional alterations, each of the diseases to which the viscus is subject is depicted and described. A similar exposition of the duodenum and its diseases is given. Facts and opinions concerning radiologic aspects of the various diseases are presented interestingly and clearly but without slavishly accepting all current hypotheses. In this latter connection, American readers will derive keen entertainment from the sections dealing with gastritis and gastric syphilis. Of gastritis, the authors say that no consistent radiologic expression can be claimed for it at this time, and that published descriptions have not been fortified with histologic proofs. The authors assert that the gastric mucosa is incessantly mobile and has constantly changing aspects, and that the rugal pattern is conditioned by the position of the stomach, by its repose or activity, by the amount of opaque medium ingested, and by the degree of intra-gastric tension. They say specifically that there is no relation between the radiologic appearance of the mucosal folds and their histologic structure or the gastroscopic picture which they present. As to gastric syphilis, it is held that this multiform disease has no pathognomonic radiologic expression, that the clinical diagnosis never rests on an indisputable basis, and that radiology is incapable of furnishing any information pertinent to an etiologic diagnosis of syphilitic lesions.

Typographically attractive with its broad pages and excellent illustrations devoid of gloss, thorough in its coverage of radiologic gastro-duodenal diagnosis and cautiously conservative in its factual statements, the new edition will be warmly welcomed by radiologists and gastro-enterologists all over the world.

UNTERSUCHUNGEN ÜBER DIE MÖGLICHKEITEN EINER DREIDIMENSIONALEN RÖNTGENOGRAPHISCHEN ABGRENZUNG INNERER ORGANE DES MENSCHLICHEN KÖRPERS (Investigations Concerning the Possibility of Outlining Inner Organs of the Human Body Roentgenographically in Three Dimensions). By CARL WEGELIUS, of Helsingfors, Finland. A volume of 148 pages, with 115 illustrations. Published by Mercators Tryckeri Aktiebolag, Helsingfors, 1934. Price, not given.

The author has undertaken extensive studies in an attempt to outline radiographically the inner organs, as, for instance, the heart in three dimensions. After a thorough analysis of the underlying theory he describes the construction of a rather complicated looking apparatus which permits the roentgen examination of patients in three dimensions. Numerous illustrations show the results obtained by this method. The assumption is made that the organs are of convex contour, and anatomic as well as physiologic facts seem to bear this out. How much more information can be gained by the author's method, and if this gain will warrant the acquisition of the special apparatus needed for this procedure, is difficult to say. The monograph is well illustrated; it also offers a short bibliography.

DIE RÖNTGENSPEKTROGRAPHIE ALS UNTERSUCHUNGSMETHODE BEI HOCHMOLEKULAREN SUBSTANZEN, BEI KOLLOIDEN UND BEI TIERISCHEN UND PFLANZLICHEN GEWEBEN (Roentgenspectrography as a Method of Studying High Molecular Substances, Colloids, Animal and Vegetable Tissue). By Dr. J. R. KATZ, of Amsterdam. A volume of 333 pages, with 187 illustrations. Published by Urban & Schwarzenberg, Berlin, 1934. Price, Rm. 20, 22 (geh. and geb.).

In the introduction the author states that there is no suitable book available, at least not simple enough for the purpose of the biologist and colloid chemist, which describes the roentgenspectroscopy of high molecular and colloid substances. According to his experience the following four problems can successfully be studied by this method: Is the substance crystalline or amorph? What is the nature of the reflecting grating? How are the elements arranged which act as grating? How large are the parts of crystals if they are too small to be measured microscopically?

After a detailed description of the technical procedure, the results obtained by roentgenspectrography in the various groups of high molecular substances are related. Among the substances discussed are proteins, cellulose and its various compounds, starch, and rubber. The low molecular colloids are dealt with in a separate chapter. Of interest to the physician is the x-ray analysis of tissue—muscle, nervous tissue, connective tissue, and hair were studied by the author. Those who attended the meeting of the Radiological Society of North America, in 1930, in Los Angeles, will undoubtedly recall a preliminary report on the same subject by Clark, of the University of Illinois.

In a concluding chapter the author offers valuable advice to the beginner in carrying out certain roentgenspectrographic examinations. He likewise includes instructions in the preparation of roentgen spectra suitable for publication. The book is well illustrated and, since difficult mathematical formulæ are avoided, it does not require a special training in physics to read and understand its contents.

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THE APPENDIX

The Solution of the Roentgen Diagnostic Problem in Chronic Appendicitis: Conclusions Based upon Studies Covering a Period of Twenty Years and Including a Comparative Analysis of Roentgenological, Clinical, Surgical, and Postmortem Findings. Thomas Scholz. Am. Jour. Roentgenol. and Rad. Ther., June, 1934, **31,** 792–814.

Eliminating from consideration the acute appendix, the author states that roentgenology should be useful in determining appendiceal pathology because of ability by this method to determine the location, either by direct or indirect visualization of this structure. The writer has made painstaking observations, in a large number of individuals, not only of their gastro-intestinal roentgen findings but also of the gross and microscopic appearances of the removed appendices, and also of the subsequent clinical condition of the appendectomized individuals, for a sufficiently long period of time after surgery was performed to determine the clinical results. He points out that both microscopic and macroscopic changes of all degrees are frequently found in clinically normal individuals, and that, therefore, abnormal pathologic findings by no means indicate a connection between clinical symptoms and the appendix. He emphasizes the point that "clinical cure" is the only satisfactory basis for determining the wisdom and effectiveness of appendectomy in the individual with a chronic abdominal complaint. On this basis he discards all so-called abnormal x-ray findings such as fixation, stasis, kinking, and spasm, and retains only the one finding of localized tenderness to palpation immediately over the barium-containing appendix as a reliable roentgenologic sign of clinical pathology. Radiographic findings are of value, therefore, merely as an aid to the surgeon in planning the operative procedure.

J. E. Habbe, M.D.

ARTHRITIS

The Orthopedic and Physical Therapeutic Treatment of Chronic Arthritis. Loring T. Swaim. Jour. Am. Med. Assn., Nov. 24, 1934, **103,** 1589–1592.

There are four objectives in the treatment of chronic arthritis: (1) to control and stop the disease; (2) to prevent deformity during the course of the disease; (3) to restore the patient to normal life as functionally capable as possible, and (4) to prevent recurrence of the disease. The orthopedist can materially aid in the success of medical treatment by securing the best use of the body through training. Faulty posture prevents normal physiologic activities and development of resistance and may retard recovery.

Arthritis is a constitutional disease. The circulation is out of order; vasomoter control is unstable; the basal metabolism rate is often subnormal; the blood pressure is low; the function of the gastro-intestinal tract is below par; there is always secondary anemia. Much of this the author attributes to disturbed physiologic functioning from faulty posture.

To prevent deformity one must anticipate the occurrence of flexion by light plaster splinting. Rest is secured, with the relief of strain and irritation. Protection at night is more important than during the day. The tendency to ankylosis must be avoided by early minimal exercise and gradual shortening of the time of rest; splints should not be left on too long. The correction of deformity and restoration of joints to normal function as far as possible are secured by rest and splinting, as above described, by corrective splinting, by manipulation of joints under an anesthetic in quiescent cases, and by open operation. Physical therapy should precede operative procedures to improve local and general circulation, to relax and develop muscles. Heat, massage, and exercise are discussed in detail.

Charles G. Sutherland, M.D.

The Medical Treatment of Chronic Arthritis. Russell L. Cecil. Jour. Am. Med. Assn., Nov. 24, 1934, **103,** 1583–1589.

Osteo-arthritis, or hypertropic arthritis, is a degenerative process which affects the bone and cartilage, a senescent process similar to arteriosclerosis or gray hair. The Germans and French speak of this condition as an "osteo-arthrosis," indicating that it is not inflammatory in nature. It is characterized by some enlargement of the ends of the bones and by an absence of soft tissue swelling. Ankylosis does not occur in this form of arthritis.

Rheumatoid arthritis, or chronic infectious arthritis, is a chronic progressive inflammatory disease, characterized in its early stages by migratory pain and swelling in various joints and in the later stages by ankylosis and deformity. In its incipient stage it is purely synovial. Hypertrophic arthritis is present in almost 100 per cent of elderly patients; trauma referable to overweight (in weight-bearing joints), occupation, bad posture and deformities are etiologic factors. In menopausal or climacteric arthritis, the patient (usually overweight), is treated by reduction of weight and restoration of basal metabolism rate, if low. Cessation of over-activity of the joint by lessening exercises is also recommended. Heat in all its forms is extremely valuable, and intestinal elimination. In the treatment of rheumatoid arthritis the elimination of trauma and the stimulation of the local circulation are the important factors.

The therapy of this disease is discussed in detail in four groups: (1) mild early cases; (2) active febrile cases; (3) well established chronic cases, and (4) advanced bedridden cases.

Charles G. Sutherland, M.D.

The Treatment of Chronic Arthritis: General Principles. Ernest E. Irons. Jour. Am. Med. Assn., Nov. 24, 1934, **103,** 1579–1583.

Chronic arthritis offers a major challenge to the medical profession and the public. It can no longer be thought of as a disease of certain joints but, rather, as a systemic illness, in which there may be disturbances of

the circulation, the general metabolism and nutrition, and the gastro-intestinal system, as well as local changes in the joints. Very early the only objective demonstrable disturbances may be in one or more joints. The immediate cause may be infection or trauma, which, however, becomes effective in producing serious disability because of the intrinsic qualities of the tissues of the patient. This broader view of the nature and causes of arthritis is rapidly gaining ground. The suffering and disability entailed by chronic arthritis exceed those from any other of the chronic diseases of temperate climes. The mortality of chronic rheumatism is low, but the suffering and disability are enormous.

Acute rheumatism was early separated clinically from chronic rheumatism and soon became distinguished as acute rheumatic fever; likewise, gout was similarly set apart clinically. The arthropathies of neurogenic origin were recognized, and still later the identification of infections due to specific organisms allowed the separation of acute and chronic arthritis associated with these infections. There was then left the large group of cases of chronic arthritis, which Garrod, in 1890, divided clinically into rheumatoid arthritis and osteo-arthritis. The view was frequently expressed then and in succeeding decades that rheumatoid arthritis was more than a disturbance of joints and depended on underlying constitutional disturbances.

The American Committee for the Study and Control of Rheumatic Diseases divided chronic arthritis into (1) chronic atrophic rheumatoid arthritis and (2) chronic hypertrophic arthritis, osteo-arthritis. In the former the incidence is chiefly in younger persons of ptotic habit, especially women. The onset may be insidious or acute, associated with infection, and a hereditary element is clearly evident at times. There is multiple joint involvement with fusiform appearance of the hands, often ulnar deflection, and later ankyloses. In many patients, constitutional effects, with slight fever, anemia, and poor nutrition are evident. Periods of spontaneous remission are a feature; improvement may last for months. Hypertrophic or osteo-arthritis usually is seen in persons at or beyond middle life, often well nourished, and it produces disability varying from slight to severe crippling. It is usually polyarticular but may be monarticular. Lipping of joints and hyperostoses are frequent; ankylosis is rare. Fibrous thickenings, Heberden's nodes, with later bony hyperplasia at the terminal joints of the fingers, are frequent. The effects of trauma and work are often noted in the hands and spine of the laborer.

The committee of the British Medical Association subdivides the rheumatoid and osteo-arthritis into groups with or without infection and adds chronic villous arthritis and spondylitis, the latter being subdivided into (*a*) ankylopoietica and (*b*) osteo-arthritica. There are borderline cases which it is difficult to place in one or the other group. Pathologic tissue changes characteristic of each group are found in the same patient, and roentgen films may show findings suggestive of atrophic and hypertrophic arthritis in the same patient. The kind of trauma and the location of the joint seem to determine, in part, the reaction that occurs. The time of life when damage occurs and the kind of reaction to injury exhibited by the tissues of the individual are factors. Treatment must be highly individualized to meet the requirements of each patient.

CHARLES G. SUTHERLAND, M.D.

BIOLOGIC EFFECTS

The Present Status of Roentgen Therapy with Voltages Above 200 K.V.: Technical Development and Medical Application. T. Leucutia and K. E. Corrigan. Am. Jour. Roentgenol. and Rad. Ther., May, 1934, **31**, 628–662.

The writers discuss the subject from the point of view of technical development as well as of the physical, biological, and clinical application of the radiation produced. Clinically, it has been determined that, with the higher voltages above 200 K.V., with appropriate filtration, two advantages in the treatment of malignant disease are obtained, these being larger amounts of radiation to the tumor and more uniform irradiation. Tumors in the oral cavity, pharynx or larynx, neck, and pelvic organs which could not be controlled satisfactorily by 200 K.V. radiation responded well to from 400 to 500 K.V. equivalent. Mixed radiation is believed at times to offer decided advantages over radiation of a single quality. It is pointed out that there is still uncertainty as to the influence the quality of radiation plays upon the biologic response, some believing that equal numbers of roentgens, regardless of quality, produce equal effects, others stating that the energy absorbed is the responsible factor, and still others holding that there is a direct dependence on the quality factor. It is obvious that many phases of the nature and action of radiations must await further investigation.

J. E. HABBE, M.D.

BONE DISEASE (DIAGNOSIS)

Congenital Preudarthrosis of the Leg: Three Cases Treated by Massive Bone Graft. Paul C. Colonna. Jour. Am. Med. Assn., Dec. 29, 1934, **103**, 2012–2016.

This is not merely a fracture that fails to unite but a pathologic condition in the bone or bones causing weakness and subsequent fracture. The bones of the leg are by far the most frequent site of the lesion; the clavicle, ulna, and femur may be involved.

The roentgenographic appearance of the bones in early cases of this disease before fracture has occurred presents a typical and characteristic picture. Areas, or an area, of rarefied bone, commence in the region of the periosteum and extend partly or completely throughout the whole diameter of the bone in the region of its lower third. It suggests a local osteitis fibrosa cystica, and a certain amount of movement may be obtained in the bone at this point, even in the absence of a fracture, due to the impairment of the bone. Cases with incomplete fracture which have been reported showed very slow union and there was no obvious callus. The type commonly seen is one in which a frank pseudo-

arthrosis is present in both bones, with a characteristic angular deformity of the lower third of the leg. The proximal bone ends are pointed and sclerosed in older cases, the distal fragments are frequently cup-shaped, with a varying degree of definite absorption between the bone ends.

There is considerable divergence of opinion regarding the etiology; however, a congenital embryonal defect is favored by the majority. The deformity is present at birth and fractures occur either at or shortly after birth, hardly ever healing spontaneously.

Operative treatment is not indicated under the age of eight.

CHARLES G. SUTHERLAND, M.D.

Os Acetabuli. Eugene Freedman. Am. Jour. Roentgenol. and Rad. Ther., April, 1934, **31,** 492–495.

The os acetabuli is a normal epiphyseal bone situated in the Y-shaped cartilage which appears at the age of fourteen and usually unites with the rest of the acetabulum at the age of eighteen. It is bilateral and is either a single or a multiple ossification center, the roentgen visualization of which depends upon its location. If it is situated in the midportion of the acetabulum, the overlapping head of the femur obscures it. If it grows laterally, its outlines can be clearly distinguished. At times, one of the bones unites earlier than the other, in which case the non-united bone can be mistaken for a fracture of the acetabulum.

The persistent os acetabuli occurs most often bilaterally, but occasionally unilaterally in individuals older than eighteen years of age. It indicates a failure of union, probably due to internal secretory disturbance. It does not represent a pathologic process.

If an irregularly defined structure resembling the os acetabuli is seen unilaterally in an older individual, a trauma, a tuberculous or an osteomyelitic sequestrum must be considered.

S. M. ATKINS, M.D.

CANCER (THERAPY)

Simultaneous Radium and Roentgen Therapy of Carcinoma of the Breast. Franz Melchart and Wilhelm Schloss. Strahlentherapie, 1935, **52,** 20–30.

During the last three years the authors treated carcinoma of the breast of all stages with a combination of radium needles and x-rays, or radium needles and teleradium therapy. Technic: Needles of various lengths, depending on the size of the tumor, are inserted at a distance of 1 centimeter. They remain 100 hours in the tissue so that per cubic centimeter of tissue there is 1 mcd. (133 mg.-hr.). This implantation is usually done under local anesthesia. Half an hour after the implantation, x-ray therapy is started (178 K.V., 50 cm. F.S.D., 0.5 mm. Cu + 1 mm. Al or Thoraeus filter, 8 to 17 r per minute, 200 to 250 r per field per day). The total dose over the breast amounted to from 2,500 to 3,000 r; over the supraclavicular area, from 1,500 to 2,000 r; over the axilla from 1,000 to 1,500 r. Two fields were given daily. A few roentgenograms are appended showing the radium needles *in situ*.

Thirty case histories are appended: 23 of these patients received radium implantation plus x-ray therapy; nine died, eight are free from symptoms up to two years and three months following the treatment, five were improved, and one had to be operated on. Seven patients were treated by a combination of radium needles and teleradium therapy: one patient lived two years and three months following the treatment; three cases were improved and free from symptoms for two, nine, and fourteen months, respectively; three cases were cured and have been observed for 11, 30, and 30 months, respectively. The authors feel that there are several advantages to this method. The radium and x-ray reactions appear at the same time and the tumor receives a maximum dose without more damage to the skin.

ERNST A. POHLE, M.D., Ph.D.

Data Concerning Three Years' Experience with 600 K.V. (Peak) Roentgen Therapy. Seeley G. Mudd, Clyde K. Emery, Orville N. Meland, and William E. Costolow. Am. Jour. Roentgenol. and Rad. Ther., April, 1934, **31,** 520–531.

At the California Institute of Technology, during the past three years, 285 cancer patients have been given roentgen therapy with 600 K.V. Only inoperable cases are accepted, a large majority showing regional lymph node metastases, but still being in fairly good general condition. Biopsy is required, the tumors being graded according to Broders' classification. Within the treatment room the tube, which is 30 feet long, is surrounded by a 2-inch thickness of lead armor. Four patients are usually treated simultaneously, the output of the tube being constantly measured in roentgen units. The effective wave length at 600 K.V., using 5-mm. steel filter and 70 cm. target-skin distance, is 0.04 Å. and the output 15 r per minute.

Moderately heavy protracted irradiation using multiple portals is the method used, 300 r being administered daily per field, and each field getting from 900 r to 1,500 r per series. Rest periods are usually four to six weeks in length and several cycles are usually administered. The skin tolerance is about 1,200 r per field.

Many instances of palliation in patients able to withstand full cycles of high voltage roentgen therapy have been observed, the results achieved comparing favorably with the effects produced by the 4-gram radium pack.

J. E. HABBE, M.D.

Roentgen Therapy of Carcinoma of the Fundus Uteri and of Post-menopausal Metrorrhagia. P. Gibert and L. Solomon. Strahlentherapie, 1935, **52,** 31–36.

The Successful Radiation Therapy of Adenocarcinoma of Fundus Uteri. H. Wintz. Strahlentherapie, 1935, **52,** 37.

While a number of gynecologists, for instance Seitz and Wintz, report excellent results in roentgen therapy

of carcinoma of the corpus uteri, Gibert and Solomon have not been able to duplicate their results. Although they used a radiation of 200 K.V. filtered through 0.5 mm. Cu or 1 mm. Zn + 2 mm. Al, four to six fields of entry, 2,000 to 3,000 r per field, the percentage of cures amounted to only 16.6 as compared with the results of Wintz (69.4 per cent in operable and 9.2 per cent in inoperable cases). The authors feel that the explanation lies perhaps in the fact that many physicians still believe that *any* post-menopausal bleeding is due to carcinoma, while careful histologic studies have shown that only 60 per cent of these patients have a malignancy. Unless there is a definite microscopic diagnosis of carcinoma, irradiated cases should not be accepted for statistical evaluation. The authors conclude that in their experience roentgen therapy alone has never cured intra-uterine carcinoma. Even the palliative results were only moderate.

In the following article Wintz offers his rebuttal to this article of the two French radiologists. He relates his own experience with roentgen therapy in carcinoma of the corpus uteri which is based on the treatment of 171 cases. Seventy-three of these, or 42.7 per cent, were well five years after the treatment. From 1916 to 1928, 95 operable cases were irradiated of which 69.4 per cent remained well after five years. During the period 1915–1928, 76 inoperable cases were irradiated of which 9.2 per cent were cured. Every one of these cases was microscopically proved to be carcinoma. In addition to that, he offers a most convincing group of 22 patients who have survived the radiation therapy for more than ten years. Two women lived 17 years; one, 16 years; three, 15 years; three, 14 years; two, 12 years; three, 11 years, and two, 10 years following the treatment. The case histories of 16 patients are abstracted; in 13 of these, photomicrograms of the biopsies are shown in the article. According to the material presented by Wintz, there seems to be little doubt that carcinoma of the fundus uteri can be cured by radiation therapy. In closing, he discusses the difference in technic as used by Gibert and Solomon and by himself. He feels that therein is, in all probability, the explanation for the poor results obtained by the French radiologists.

ERNST A. POHLE, M.D., Ph.D.

The Value of Irradiation in the Treatment of Ovarian Carcinoma. John H. Harris and Franklin L. Payne. Am. Jour. Obstet. and Gynecol., January, 1935, **29**, 88–92.

These authors present 38 cases of ovarian carcinoma treated by roentgen rays. Results confirm those of a similar series reported by Keene, Pancoast, and Pendergrass, who concluded that it is impossible to predict the effect of irradiation in any given patient, that in generalized carcinomatosis without removal of the primary growth little can be expected from treatment, and that with removal of the primary growth outlook for relief of symptoms is more hopeful. Harris and Payne add to these conclusions a better prognosis for palliation and for prolongation of life due to improvement of technic. The histologic type of carcinoma is of no value in determining what the effects of roentgen therapy will be.

Cases are grouped according to extension of the growth and compared with a group of 51 similar cases treated by operation alone. While the groups are too small for statistical analysis, results show a distinctly beneficial effect with irradiation both in prolongation of life and in relief of symptoms.

The technic of treatment is outlined.

W. A. SODEMAN, M.D.

The Histological Classification of Cancers of the Uterine Cervix and the Relation between the Growth Structure and the Results of Radium Treatment. H. Chambers. Am. Jour. Cancer, January, 1935, **23**, 1–15.

Chambers has analyzed 500 cases of cancer of the cervix to determine the relationship between their structure and the results of radium therapy. The method of grading, an inherently difficult problem, is based on the extent of differentiation and degree of cell activity, with a consideration of the general architecture of the growth as well. Squamous-cell types are divided into four grades: Grade I includes all typical cases of the adult common type of squamous carcinoma; Grade II, the types composed of the spindle cells; Grade III consists of all cases in which there is a clear tendency to form stratified epithelium with subgrouping according to extent of differentiation; Grade IV includes all anaplastic growths showing no formation of stratified epithelium. Treatment used is the technic of Forssell modified to improve the distribution of the radium. No modifications were made for various histologic types.

The highest percentage of local cures, 73.8 per cent, was obtained in the squamous group, Grade III, transitional type. In adenocarcinoma no evidence of insensitivity to radiation was obtained, local cures occurring in 72.9 per cent of the cases. None of the histologic grades showed a difference of more than 15 per cent in either local cures or in the number of three-year survivors.

W. A. SODEMAN, M.D.

Hyperintensive Irradiation of Certain Types of Carcinoma: Preliminary Report. H. Lammers. Strahlentherapie, 1935, **52**, 51–60.

The author has treated a number of cases of advanced carcinoma of the breast with a multiple field method. Technic: 200 K.V., 0.5 mm. Cu, 16 cm. F.S.D., 18 r/min., dose per area 1,200 r. The advantages of this procedure are the short treatment time, the relatively high doses, and the absence of pleura and lung injuries. In a future publication results obtained in earlier cases of carcinoma of the breast will be reported. Six case histories are appended.

ERNST A. POHLE, M.D., Ph.D.

Roentgen Therapy of Carcinoma of the Pharynx. H. Coutard. Strahlentherapie, 1935, **52**, 1–10.

During the period 1921–1926 the author treated 89

cases of carcinoma of the pharynx: 55 of these were living at the end of the first year, 30 at the end of the second, 14 at the end of the third, 14 at the end of the fourth, 11 at the end of the fifth, 10 at the end of the sixth, and 8 (9 per cent) at the end of the seventh year. The treatment was carried out with the well-known protracted fractional dose method and from 6,000 to 8,000 r were applied to the skin. The average field size was from 75 to 125 sq. cm., the tube potential 200 K.V., with 2 mm. Zn + 3 mm. Al as filter. The F.S.D. varied from 40 to 60 centimeters. In each case the treatment was carried up to the point of marked skin and mucous membrane reaction.

An analysis of the cases showed that all epitheliomas which remained cured had not infiltrated the surrounding tissue. An increase in the dose was usually of no benefit and sometimes injurious. A prolongation of the treatment time obviously improved the results. It varied for the various types of carcinoma from 25 to 60 days. The degree of reaction seemed to be mostly influenced by the growth characteristics of the cancer and not by the applied dose or any individual variations in susceptibility. The time factor was of little influence in the treatment of non-infiltrating carcinoma, but seemed to be of decisive influence in the irradiation of infiltrating carcinoma. Brief case histories of two patients are appended. There are also lateral roentgenograms of the larynx of each patient before and after radiation therapy.

ERNST A. POHLE, M.D., Ph.D.

DOSAGE

Roentgen-ray Standards and Units. Standardizing Procedure of the National Laboratories. Am. Jour. Roentgenol. and Rad. Ther., June 1934, **31,** 815–818.

This is a brief article presenting standardization efforts by the National Bureau of Standards (United States of America), National Physical Laboratory (Great Britain), Physikalisch-Technische Reichsanstalt (Germany), and Service d'Etalonnage de l'Hôpital St. Antoine (France). Heterogeneous roentgen rays are classified as follows: "ultra-soft" (Grenz) radiation with a range of from 5 to 20 K.V.P. applied potential, with an equivalent "end-radiation" limits of from 2.5 to 0.6 Ångstrom units; "soft" radiation ranging from 20 to 120 K.V.P., with end-radiation limits of from 0.6 to 0.1 Ångstrom; "hard" radiation ranging from 120 to 250 K.V.P., with end-radiation limits of from 0.1 to 0.05 Ångstrom, and "extra hard" radiation ranging from 250 K.V.P. upward, with end-radiation limits less than 0.05 Ångstrom. The article considers measurements of quality, measurement of the roentgen, and calibration of dosimeters.

J. E. HABBE, M.D.

Variations in Dosage Dependent on Wave Length. M. C. Reinhard. Am. Jour. Roentgenol. and Rad. Ther., April, 1934, **31,** 538–540.

According to the writer, radiation dosage is approximately inversely proportional to the absorption, or, in other words, the more penetrating the beam the less is the absorption per unit volume and the greater is the amount of radiation which may be administered before reaching, for example, the skin tolerance. A curve showing the relation between wave length and mass absorption coefficient for water is constructed, also curves for determining the skin erythema dose in roentgen units from the effective wave length, and for determining the relation of effective wave length to half value layer measured in copper and aluminum.

J. E. HABBE, M.D.

ENCEPHALOGRAPHY

Encephalography under Nitrous Oxide Anesthesia. R. W. Waggoner and L. E. Himler. Am. Jour. Roentgenol. and Rad. Ther., June, 1934, **31,** 784–786.

The writers recommend nitrous oxide anesthesia in preference to ether or sodium ethyl barbiturate as a safe means, without any attendant undesirable features, for minimizing the discomfort during and following encephalographic examinations. Patients ranging in age from two to fifty-six years have been examined with the aid of nitrous oxide, and no unfavorable changes in pulse, blood pressure, respirations, or cell counts were recorded which might not also have occurred without any anesthetic being administered.

J. E. HABBE, M.D.

ESOPHAGUS (DIAGNOSIS)

Disturbed Peristalsis of the Esophagus, with Formation of Pseudo-diverticula. J. Palugyay and G. Pesek. Röntgenpraxis, July, 1934, **6,** 417–420.

Cases of so-called functional (Bársony) or false diverticula (Gregoire) of the esophagus have been described occasionally. The case reported by the authors showed, on fluoroscopic examination, multiple constrictions and sac-like pseudo-diverticula in the lower third of the esophagus. They appeared for a few seconds only after swallowing and disappeared after the peristalsis stopped; the esophagus then presented a very normal appearance. The patient complained little of esophageal symptoms. An examination ten months afterward showed the same picture and administration of belladonna did not change the spasm and sac-like deformities. The appearance and disappearance of the so-called diverticula were always in direct connection with the peristalsis.

Because the false diverticula are always seen in the same areas of the esophagus, the authors believe that there must be an organic change in the wall of the esophagus which disturbs the normal course of the peristaltic waves.

HANS W. HEFKE, M.D.

EXPERIMENTAL STUDIES

The Influence of Roentgen Irradiation on the Blood Sugar of Rabbits and Their Suitability for Blood Sugar Experiments. J. Engelbreth-Holm. Strahlentherapie, 1935, **52,** 101–114.

The author has carried out extensive blood sugar

studies on rabbits under various conditions in order to determine their suitability for experimental purposes. She comes to the conclusion that, in view of the instability of the blood sugar level in rabbits, they are not suitable for experiments in cases in which changes of the blood sugar are to be used as the indicator.

ERNST A. POHLE, M.D., Ph.D.

THE EYE

A Simple Technic for the Radiography of the Optic Canals. Cesare Fava. Arch. di Radiol., 1934, **10,** Pt. 1, 364–369.

Fava lays the patient with his forehead on the Potter-Bucky diaphragm in the usual position for sagittal exposure of the skull. The external occipital protuberance and the apex of the mastoid are marked, and the head is rotated until these two points come into line. The x-ray tube is placed at a meter distance, centering on Busi's point. The author shows some radiographs taken by this technic.

E. T. LEDDY, M.D.

FOREIGN BODIES

A Method of Roentgen Localization of Foreign Bodies in the Stomach Prior to Gastroscopic Removal. Gabriel Tucker. Jour. Am. Med. Assn., Nov. 10, 1934, **103,** 1440, 1441.

In a recent case in which there was supposed to be a piece of wire in the stomach, it was desired to localize it definitely and at the same time to show its relation to the cardiac end of the stomach and the hiatal esophagus. In order to do this the patient swallowed a rubber tube, which passed through the hiatal esophagus and cardia, coiling itself around the greater curvature of the stomach, giving its relation to the foreign body in the anteroposterior and lateral planes. The tube was used to empty the stomach before gastroscopy.

If desired, air could be insufflated into the stomach through the tube before its withdrawal.

CHARLES G. SUTHERLAND, M.D.

GALL BLADDER (NORMAL AND PATHOLOGIC)

Some Studies on the Mechanism of Rapid Cholecystography. Antonio Capua. Arch. di Radiol., 1934, **10,** Pt. 1, 370–376.

The author studied the time of the appearance of the cholecystogram after injecting substances which stimulate secretion of bile. The cholecystogram appeared slightly earlier than with the usual endovenous method of Graham. He, therefore, feels that bile-stimulating substances have only a secondary effect in the production of the cholecystogram.

E. T. LEDDY, M.D.

Diverticulum of the Gall Bladder. Jacob H. Vastine. Am. Jour. Roentgenol. and Rad. Ther., May, 1934, **31,** 603–606.

Diverticula of the gall bladder are not an uncommon finding at operation or autopsy. Their etiology is uncertain but it may be pulsion, traction, or congenital. Two cases are reported which were diagnosed by cholecystography. In one, there was a positive shadow adjacent to the filled gall bladder characteristic of a gallstone (1 cm. in diameter), and the fundus adjacent to it was indented. The second showed a separate shadow (1 cm. in diameter) adjacent to the gall bladder. These must be differentiated from congenital malformations as double gall bladder, hour-glass gall bladder, redundant gall bladder, and pericholecystic adhesions. The differentiation should be made easier by films taken at different angles. Films made after a fat meal showed the decrease in size of the diverticulum less than the gall bladder, due to the absence of muscle fibers in the wall of the diverticulum.

S. M. ATKINS, M.D.

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

Colon Studies: VII. Variations in Fixation of the Cecocolon; Their Clinical Significance. John L. Kantor and Samuel Schechter. Am. Jour. Roentgenol. and Rad. Ther., June, 1934, **31,** 751–765.

Normally, the ascending colon becomes attached to the posterior abdominal wall by about the sixth or seventh month of fetal life. Departures from this normal may be an arrest in the process of fixation, with persistence of the primitive mesentery and increased mobility, or abnormal progression of fixation resulting in excessive adhesions. At times the former may cause excessive adhesions. The principal points at which a normal fixation of the right colon may become accentuated are at the beginning transverse portion, hepatic flexure, and at the cecum. An atypical one is the pericolic hyperfixation, or Jackson's veil.

The average location, roentgenographically, of the hepatic flexure in the prone position nine hours after a standard opaque meal is slightly over three inches above the crest of the ilium. It is about one-half inch higher in males than in females. In the erect posture, the average position is slightly less than one and one-half inches above the ileum and about two-thirds inch higher in males than females. The average position of the cecum in the prone is about one and one-half inches above the top of the right acetabulum, being one inch higher in males than females. In the erect posture the average is one-sixth inch above the acetabulum and one inch higher in males than in females.

The average length of the cecocolon, both prone and erect, is 6.82 inches. In females it is one-fourth inch greater in the prone and one-tenth inch greater in the erect position than in males. The greatest vertical mobility of the hepatic flexure was $4^{3}/_{4}$ inches and of the cecum $4^{1}/_{4}$ inches. The average range of mobility in the shift from the prone to the erect position was $1^{2}/_{3}$ inches for the hepatic flexure and $1^{1}/_{3}$ inch for the cecum. The greater mobility of the hepatic flexure, which occurred in 61 per cent, may be due to shift in the plane.

Excessive mobility was arbitrarily diagnosed when the vertical excursion reached 3 inches for the hapatic flexure and 2.5 inches for the cecum, and excessive fixation when the vertical range in mobility resulting from change in posture was one inch or less. Excessive mobility was present in 10.4 per cent, of which 60 per cent were females and four times as many in sthenics as in asthenics. High cecal incidence was over twice as great as normal in the hepatic flexure mobility cases, and in the incidence of hepatic flexure mobility was slightly higher than normal in the high cecal cases. Low cecal cases in the hepatic flexure mobility series were slightly below normal figures.

Excessive mobility of the cecum was exactly that of the hepatic flexure; males were 52.5 per cent. Sthenics show striking predominance over asthenics; 55 per cent of the former and 7.5 per cent of the latter. With this mobility the incidence of high cecum was great. Excessive mobility of both hepatic flexure and cecum was rare.

Excessive fixation of the hepatic flexure occurred in 27.9 per cent with 60.7 per cent for males, with habitus not of significance. Excessive fixation of the cecum was present in 43.3 per cent, with asthenics slightly predominating. Excessive fixation of both cecum and hepatic flexure was 19.8 per cent.

The clinical significance of excessive mobility of the hepatic flexure or cecum seems practically *nil;* however, in cases of non-fixation of the cecocolon there can occur such conditions as volvulus of it, ileocecal intussusception, or prolapse of the cecum through a hernia. Headaches, vomiting, right-sided pain or tenderness, constipation, and cecal stasis were not increased. Colitis was slightly more in cecal hypermobility, and gallbladder disease was found twice as often as in the normal and four times as often as in the fixed hepatic flexures.

As to the clinical significance of excessive fixation, hepatic flexure fixation is more intimately connected with colonic irritability than with colonic stasis. Gallbladder disease is less frequent than in the normal and excessively mobile. Headaches and vomiting as well as pain and tenderness are not affected.

These cases are not surgical but, rather, medical, except the patients with acute volvulus or intussusception.

S. M. ATKINS, M.D.

The Syndrome of Hypertonic and Atonic Colopathy. Fred H. Kruse. Jour. Am. Med. Assn., Nov. 3, 1934, **103**, 1366–1370.

The author suggests limitation of the term "colitis" to inflammatory states of the large bowel. These inflammations, from simple catarrhal to chronic ulcerative colitis, as well as related conditions producing definite pathologic lesions, have been well demonstrated and their causative agents have been determined. These range from chemical poisons, certain deficiency states as noted in pellagra and sprue, protozoan infestations and, above all, bacterial infections. The chronic colopathies characterized by constipation and intermittent diarrhea, represent by far the greater proportion of chronic bowel disorders that occur without any evidence of definite pathologic lesions of the mucous membranes. The cause of this condition has been assigned, on the one hand, to constitutional and functional origin, and, on the other, to local irritative lesions or more general metabolic disorders.

Students of the more chronic colopathies recognize a probable congenito-functional origin, since the causes of chief influence are partly congenital but inherently functional, and are manifested by certain psychic and anatomic disturbances of the nervous system.

It is the inco-ordination of muscular motor function rather than its paralysis or absence that is at the base of all constipation, except in the definitely mechanical obstructive types.

There is a uniform tendency for hypertonicity to be more apparent in shorter and more normal forms, whereas atonic loops and states appear more frequently as the bowel becomes more redundant.

The main factors involved are the relative activity at various periods of the parasympathetic and sympathetic divisions of the autonomic nervous system. The parasympathetic (craniosacral), notably the vagus, is the activator, carrying fibers that increase secretion, produce spasticity and motor activity, and, if overstimulated, cause the excessive formation of mucus and lead to colic and hyper-irritability. The sympathetic system (with its paravertebral ganglions) is the inhibitor or depressor, the direct antagonist of the parasympathetic. Stimulation or activity of this system leads to relaxation and loss of tone and to checking of secretion.

The hypertonic colopathies include the spastic colon, the irritable colon, and mucous colitis. A preponderance of evidence indicates that the syndrome of the spastic, irritable colon is a visceral neurosis (in some respects akin to asthma), and exists only in persons with unstable or poorly co-ordinated nervous systems.

Nature has provided for retention or favorable stagnation in the normal cecum. When the fluid contents are projected rapidly to the distal colon, irritation, fermentation, impaired absorption of intestinal gases, colonic spasm and pain, and systemic toxic effects result. On the other hand, when the contents of the proximal colon are held too long, the dry inspissated residue produces a similar result, though with different characteristics. In functional colon disturbance are found: (*a*) spasm, most pronounced in the descending and sigmoid colon; (*b*) peristalsis and antiperistalsis, greatly increased in the cecum and adjacent bowel, with prolonged stasis, and (*c*) excessive mucous secretion. An underlying neurosis is the essential factor that produces this type of habitual constipation and irritable colon.

The stools show great variation in form and shape, ranging from naturally formed to mushy or watery, or with alternating periods of small, dry, marble-like masses, followed by diarrheic looseness and great quantities of mucus. They are essentially negative on microscopic examination, although occasionally a few

blood cells may be noted. The sigmoidoscopic examination is primarily important in ruling out early ulcerative colitis, amœbic dysentery, rectal ulcer, and neoplasm of the rectum and lower sigmoid. This examination should always be made.

Visualization by the roentgen ray of different portions of the gastro-intestinal tract is chiefly of value in demonstrating or ruling out pathologic conditions not related to form or function.

The most important procedure is to follow the barium meal down through the tract, to judge approximately the disturbance of motility and the degree of irritability, stasis, and fermentative processes. The normal bowel is usually only partially empty, while in the irritable bowel only a trace of barium is left in the colon. The barium enema is important, but since it relaxes spasm it may mislead the observer entirely as to the motor function of the bowel.

Irritability may vary at different periods from the normal to varying degrees of general spasticity, segmental irritation phenomena, hurried or delayed emptying, a spastic sigmoid with a large dilated cecum, a feathery descending colon simulating the appearance of the small bowel, and occasionally (10 per cent) the "string sign."

Treatment is essentially soothing and sedative; reconstructive both pyschologically and physically. It must include a regimen of colon management, which the author has outlined in detail.

CHARLES G. SUTHERLAND, M.D.

Regional (Terminal) Ileitis: Its Roentgen Diagnosis. John L. Kantor. Jour. Am. Med. Assn., Dec. 29, 1934, **103,** 2016–2020.

Following the ingestion of the standard opaque meal, administered on an empty stomach, observations are made at hourly intervals from three to nine hours after the ingestion of the opaque meal. The patient is allowed to take an ordinary meal as soon as the stomach is seen to empty; normally five hours after the barium meal. The changes in the colon are usually the result of spasm secondary to the ileac involvement. The spasm in ileitis takes the form of a contracture, sometimes of the entire cecocolon, but most characteristically of the cecum proper. There is often a marked spasm of the sphincter of Busi (a sphincter separating the cecal tip from the cecum above it), as well as of the cecal tip, so that this segment assumes a special bud-like or teat-like appearance. In most cases of spasm of the cecum or cecocolon the changes are not constant when functional, but intermittent. Furthermore, the opaque enema usually suffices to fill out the involved areas in normal fashion.

On the other hand, the colon may be actually involved by the disease process in the adjacent ileum, as by adhesion or fistula formation. In such instances a fixed deformity results, most commonly affecting the inner (mesial) aspect of the large intestine. There is a constant defect in the filling of the terminal small intestine. The extent of this ileac filling defect depends on the extent of the stenotic process in the small intestine. In three of the author's six cases the ileum proximal to the filling defect seemed abnormal in contour. The involved loops appeared irregular in shape, or else the very last segment of ileum showed a peculiar taper point. In some cases this taper point became continuous with a thin, slightly irregular linear shadow suggesting a cotton string in appearance and extending more or less continuously from the region of the last visualized loop of ileum through the entire extent of the filling defect to the ileocecal valve. This latter is the "string sign" and represents the attenuated barium filling of the greatly contracted intestinal lumen. Multiple or branched "string signs" may be attributed to multiple areas of involvement or to fistula formation.

In differential diagnosis it is characteristic of regional ileitis that the "string sign" remain constant in location at repeated observations. This sign is not necessarily pathognomonic of regional ileitis, but its presence should suggest the disease.

CHARLES G. SUTHERLAND, M.D.

Duodenitis and its Roentgenologic Characteristics. B. R. Kirklin. Am. Jour. Roentgenol. and Rad. Ther., May, 1934, **31,** 581–587.

Duodenitis is held by MacCarty and Nagel to be an antecedent lesion to ulcer, although this is denied by Hauser, Büchner, Knötzke, and Radecke. Grossly, duodenitis shows hyperemia and stippling of the mucosa without induration of the wall, and more or less diffused inflammation of the mucosa, with, at times, small superficial erosions which bleed easily. Microscopically, there is cellular destruction, congestion, and edema, with migration of leukocytes, lymphocytes, and endothelial cells. Clinically, there are no notable differences in the individual with duodenitis as compared with the one suffering from an actual ulcer. Roentgenologically, these criteria for making a diagnosis of duodenitis are tentatively offered by Kirklin: irritability of the bulb, with rapid emptying and pronounced but unstable deformity, indistinctness of bulb outline, absence of niche or crater, and absence of gastric retention. There is, at times, a rather characteristic, coarsely reticulated mucosal pattern. Of 92 cases roentgenologically diagnosed as uncomplicated duodenitis, only eight were submitted to surgery, the remainder being cases considered suitable for medical care. In several cases ulcer and duodenitis co-existed, both lesions being recognized to be present by roentgen examination prior to operation.

J. E. HABBE, M.D.

Some Mechanical Factors of Gastric Physiology. Study I. The Empty Stomach and its Various Ways of Filling. The Pressure Exerted by the Gastric Walls on the Gastric Content. The Physical Changes Occurring to the Foodstuff during Digestion. Cesare Gianturco. Am. Jour. Roentgenol. and Rad. Ther., June, 1934, **31,** 735–744.

Some Mechanical Factors of Gastric Physiology. Study II. The Pyloric Mechanism—The Effect of Various Foods on the Emptying of the Stomach.

Am. Jour. Roentgenol. and Rad. Ther., June, 1934, **31,** 745-750.

In the first study small chilled lead shot were placed under the serosal coat of the stomach of cats and these stomachs were studied roentgenologically with the use of air or barium suspended in various fluids. Pressure conditions were measured by air through a tube.

"Hunger contractions" in the fasting stomach were not demonstrated fluoroscopically except in one cat that showed much gas in the stomach, but of eight films, each including 100 roentgenograms, seven showed shallow peristaltic contractions. It seems that the large amplitude of contractions seen when the balloon is used is due to the stimulus of distention.

On an empty stomach the *Magenstrasse* (lesser curvature) is not functionally distinguished either with small or larger quantities of food, liquid or solid. The lesser curvature is followed only when small amounts of material enter a stomach already filled with solid food. Large amounts entering a full stomach spread from the cardia out around the food already present.

Up to a certain point the stomach relaxes as it fills but beyond that point the intragastric pressure increases. The parts relaxing were shown to be the fundus and upper and outer parts of the body only. The increase is due to stretching of the abdominal walls. With increased pressure, as produced by resection of the fundus, the emptying time was shortened.

During digestion, liquefaction of the food occurs first in the pylorus and is due probably to the more active peristalsis in this region, also to the trickling down from above. When solids and fluids are mixed, the fluids leave first and this phenomenon is probably due to the peristaltic waves acting like the hand of a milker.

In the second study, with lead shot placed under the visceral serosa of the two curvatures of the stomach, pyloric ring, and contours of the duodenum in cats, cinematographic roentgenographic records of every phase of gastric activity were made. The conclusions were that the pylorus responds as the adjacent part of the pars pylorica, that food leaves the stomach when the pylorus and duodenum are relaxed at the same time, and that relaxation of the pylorus alone is not followed by passage of food.

The emptying time of different foodstuffs depends first on the physical condition, consistency, and size of the particles, and second, on the chemical nature of the substance. Fats and hypertonic solutions of salt or sugar had the most conspicuous effect in slowing the emptying of the stomach. The reason for the slowing is due to marked changes in the activity of the gastric and duodenal walls, since slow emptying persisted even after the removal of the pyloric ring and after gastroenterostomy.

S. M. Atkins, M.D.

Roentgen Diagnosis of Diseases of the Colon: An Evaluation of Methods. Harry M. Weber. Am. Jour. Roentgenol. and Rad. Ther., May, 1934, **31,** 607–613.

After reviewing the history of examination of the colon roentgenologically, the author notes that the current methods of visualizing the large bowel are the contrast meal, the contrast enema, the study of the mucosal relief, and the double contrast enema. Although the contrast meal is the most nearly physiologic, nevertheless, the weight of the meal and the various methods of its preparation cast doubt on its action being like that of an ordinary meal. Obstruction when present in high degree is made manifest, but the accumulation of the material above the obstruction is bad.

Local or general hypermotility observed in ulcerative lesions is fairly constant, but this is only an indirect sign, whereas other methods can show the condition directly. When this method is rigidly controlled, as in recognition of intestinal tuberculosis, the evidence supplied merits consideration.

Roentgenoscopic observation of the contrast enema is the method of maximal efficiency for all types of disease, since not only are there revealed the visual elements but also those supplied by topical manipulation, mobility, flexibility, and the character and persistence of defects can be noted. In most instances of organic disease it is possible to elaborate a pathognomonic roentgenologic syndrome from the data elicited from this examination alone. From this examination, indications for additional refined technics are decided, such as roentgenography of the bowel while distended with the opaque enema, and special examination of the mucosa and internal topography after evacuation, both before and after distention with air or gas. Inspection of the mucosal relief and the double contrast method show changes in the mucosa and the internal topography which the older methods lacked. The double contrast method possesses the advantage of demonstrating polypi accurately. It also shows distinctly significant anatomic characteristics of lesions.

As a matter of principle, the complete roentgenologic examination will include all methods necessary for a complete diagnosis.

S. M. Atkins, M.D.

GENITO-URINARY TRACT (DIAGNOSIS)

Fatal Gonococcal Pyemia Following Internal Urethrotomy. Geoffrey E. Parker. British Jour. Urol., December, 1934, **6,** 363, 364.

The author reports a case of fatal gonococcal pyemia following internal urethrotomy. Many metastatic foci developed, followed by the ultimate death of the patient from suppression of urine.

Davis H. Pardoll, M.D.

Report of a Case of Tuberculosis of Urinary Tract, with Some Evidence of Spontaneous Healing. J. Gray and S. T. Hsiu. British Jour. Urol., December, 1934, **6,** 357–363.

The author reports a case of tuberculosis of the urinary tract with some evidence of spontaneous healing.

Davis H. Pardoll, M.D.

The Roentgenogram of Hydronephrosis Due to an Aberrant Blood Vessel. Jepkens and Loeweneck. Röntgenpraxis, July, 1934, **6,** 421–424.

In 18 out of 40 cases of hydronephrosis an aberrant blood vessel with or without peri-ureteritis was the cause for the dilatation of the kidney pelvis. All cases were checked by operation. In order to show the uretero-pelvic junction best on roentgenograms the authors employ first an intravenous pyelogram. If that looks suggestive, a large catheter is introduced into the ureter and the patient is examined fluoroscopically in standing and prone positions. After the best position for showing the uppermost portions of the ureter has been found fluoroscopically, a film is immediately taken with the apparatus of Berg for instantaneous exposures. If the ureter is smooth, but kinked, one is dealing with an aberrant vessel; if it is kinked and irregular in contour, there is always some scar-like thickening around the ureter.

HANS W. HEFKE, M.D.

Granuloma of the Bladder. A. F. Weyerbacher and James F. Balch. Am. Jour. Surg., January, 1935, **27,** 168–170.

Granuloma of the bladder, although frequently encountered by the urologist, has received little attention in the literature. Because hematuria and pyuria frequently occur with granuloma, it is of real importance from a clinical standpoint. A correct diagnosis of granuloma of the bladder presupposes proper management of the case.

DAVIS H. PARDOLL, M.D.

Traumatic Interstitial Hernia of the Bladder. Richard Joseph White. Am. Jour. Surg., January, 1935, **27,** 174–176.

It is hard to see any explanation of the unusual findings here presented except sudden, severe pressure on a distended bladder which, instead of rupturing, forced a portion of its wall through the fibers of an ordinarily very strong tendinous structure. The latter may have been weakened by former wearing of a truss. In any case, the lateral pressure of the tense fibers of the tendon evidently allowed more fluid to go into the artificial pouch when the bladder was distended than it permitted to flow back when the bladder was empty.

The interchange must have taken place or infection would surely have resulted. Likewise, it must surely have been very slow or a recognizable change in size in the swelling when the bladder was emptied could have been detected. The relief from pain on voiding secured by pulling the mass laterally was probably due to the fact that the wall of the pouch was thus brought in line with the oblique tear through the tendon, lessening the pressure of the sharp inner fascial edge against it.

DAVIS H. PARDOLL, M.D.

GOITER (THERAPY)

The Roentgen Therapy of Flajani-Basedow's Disease. Eugenia Jona. Arch. di Radiol., 1934, **10,** Pt. 1, 377–414.

The author reports a detailed clinical and laboratory study of nine cases of exophthalmic goiter made after x-ray treatment.

E. T. LEDDY, M.D.

GYNECOLOGY

Roentgenologic Diagnosis of Placenta Previa. Walter H. Ude and John A. Urner. Minnesota Med., January, 1935, **18,** 9–11.

The authors succeeded in demonstrating roentgenologically the presence of placenta previa in 14 patients of a series of about 35 cases of abnormal uterine hemorrhage. In all of the cases, independent clinical examinations were carefully and thoroughly performed and the results obtained by the use of the roentgen ray confirmed the clinical diagnosis in each case.

In 1930, Menees, Miller, and Holly reported their method of roentgenologic visualization of the placenta by the injection of a solution of strontium iodide through the anterior abdominal wall into the amniotic cavity. It is believed, however, that this method may be dangerous to the fetus, and may result in premature delivery. Kerr and Mackay substituted a derivative of iopax for the strontium iodide, but it is thought that the termination of pregnancy may result from this injection. Snow and Powell later demonstrated the outline of the normally implanted placenta without the injection of a contrast medium. The authors subsequently reported the roentgenologic diagnosis of placenta previa in a case of uterine hemorrhage, in which the clinical diagnosis was placenta previa. This was confirmed at operation.

The authors' technic consists of the injection of not more than 40 c.c. of sodium iodide or other contrast medium into the urinary bladder after catheterization. This is done to clearly define the upper margin of the bladder. The roentgenogram is then made with the central ray directed vertically over the lower abdomen.

In the normal case of pregnancy with the fetal head presenting in the lower uterine segment, the normal soft tissue space between the cranial bones of the fetus and the contrast material in the bladder consists of the thin scalp of the fetus, the wall of the lower uterine segment, the fold of the peritoneum, and the relatively thin wall of the bladder. The roentgenogram reveals this area as a narrow band of tissue, scarcely exceeding one centimeter, between the two landmarks. In the presence of placenta previa this space is widened and usually the outline of the placental mass may be seen on the film. It has been possible for the authors to distinguish between central and partial types of placenta previa by a study of the size and position of the placental mass in the lower uterine segment. While it was impossible to apply this method to a case of transverse presentation associated with placenta previa, it is believed that in the case of breech presentation the outline of the breech should give a sufficiently clear definition of the upper margin of the placental mass.

J. N. ANÉ, M.D.

Personal Technic for the Cure of Epispadias in Women. Oscar Mercier. British Jour. Urol., December, 1934, **6,** 313–319.

The author describes his personal technic for the cure of epispadias in women. Many illustrations describing the steps for the eradication of this condition are reproduced in the article. His success is largely dependent upon the fact that the tissues of the incomplete sphincter are brought together to surround a reformed urethral canal.

DAVIS H. PARDOLL, M.D.

HEART AND VASCULAR SYSTEM

Congenital Cardiac Disease in Infants, with a Discussion of Tracheal Displacement as a Roentgen Sign. Eugene P. Pendergrass and M. Lowry Allen. Am. Jour. Roentgenol. and Rad. Ther., April, 1934, **31,** 470–481.

Tracheal displacement in inspiration was radiographically demonstrated in nine cases of congenital heart disease. All showed abnormal posterior displacement, while six showed definite right lateral, and one, left lateral displacement. In some, the maximal displacement was as high as the suprasternal notch, in others as low as the bifurcation. It is the writers' belief that the displacement is most commonly the result of abnormal relationship of the great vessels which are in close relationship to the trachea. The tracheal displacement is similar to that noted in thymic enlargement; differentiation as to cause which cannot be made, taking the other abnormal x-ray findings into consideration, may be aided by the therapeutic test, the abnormal finding disappearing promptly after irradiation if caused by the thymus, but, of course, persisting if due to congenital heart disease.

Accurate positioning in both the postero-anterior and lateral positions is, of course, essential to accurate interpretation of tracheal deviation. Films are taken in both the inspiratory and expiratory phases with the subject erect. Deviation or buckling is normally encountered in the expiratory phase film.

The authors warn that this observation has been made only in infants and, therefore, it is not to be assumed that older children or adults will show the same sign with the same frequency.

J. E. HABBE, M.D.

Roentgen Diagnosis of Coronary Disease. George Levene, Frank E. Wheatley, and Helen Matthews. Am. Jour. Roentgenol. and Rad. Ther., May, 1934, **31,** 588–592.

Roentgen manifestations of coronary disease are gross visual evidence of pathologic cardiac physiology. The pathologic changes may attack all of the coronary vessels, although the one most commonly and extensively involved is the left circumflex. With thrombus formation, the myocardium supplied by the involved branch becomes first edematous and anemic, later an infarct forms, with predisposition to aneurysm formation.

The bisector measurement of the left ventricle is a summation of two values—the thickness of the ventricle muscle and the muscle tone. In ventricular hypertrophy, the bisector increases above the normal figure of 8 to 10 mm., while in myocardial impairment there is loss of tone, with resultant decrease of the bisector.

The typical appearance of myocardial disease is, therefore, a straight left cardiac contour, a small bisector, low-placed right and left median diameters, and greatly diminished cardiac contractions.

If there has been a long-standing antecedent hypertension the roentgenographic picture will be atypical in that the left ventricular contour may still be rounded and the bisector large; however, the contractions remain characteristically weak. Not infrequently in this latter type of case there will be a functional mitral insufficiency.

J. E. HABBE, M.D.

Myocardial Calcification. John J. Moore. Am. Jour. Roentgenol. and Rad. Ther., June, 1934, **31,** 766–769.

In contrast to cases of pericardial calcification shown roentgenologically, proven cases of myocardial calcification so demonstrated and confirmed by necropsy are rather rare. The author's case was that of a male, aged 60 years, who had complained of precordial pain, brought on by exertion, for a short period of time prior to death, although the patient had been aware of "heart trouble" for about nine years. On previous examinations he had complained of sinus trouble and had shown normal blood pressure readings of 135/80. About two months prior to death, his heart was examined roentgenologically for the first time. This study revealed an ovoid area of calcification of basket-weave appearance, measuring $7 \times 6 \times 5$ cm., lying in the wall of the left ventricle. Also, a ring-like area of calcification was seen in the vicinity of the mitral valve. Less than two months after detection of the mural calcification, the patient suffered an acute attack of precordial pain, showed an irregular pulse, and a blood pressure of 78/55; he died the same day. A postmortem study showed a heart weighing 545 grams, the wall of the left ventricle bulging and containing a large deposit of calcium within it. The myocardium elsewhere appeared normal. Both coronaries were quite sclerotic, the immediate cause of death being attributed to occlusion of a branch of the left.

J. E. HABBE, M.D.

Roentgen Therapy of Carditis and Aortitis. Boris Jegorow. Strahlentherapie, 1935, **52,** 97–100.

The author relates in a preliminary report his experience with roentgen therapy of inflammatory lesions of the heart and aorta. The technic was that used as a rule in inflammatory lesions: three to five sittings were given once a week, and, if repeated, at intervals of from one and a half to three months. Most striking was the relief from pain, particularly in pericarditis and myocarditis. Seven cases of endocarditis lenta were

also irradiated. Four of the patients died, probably because roentgen rays were used in the end-stage of the disease, while three recovered: one has been under observation for two years and nine months.

ERNST A. POHLE, M.D., Ph.D.

HEMOPHILIA

The Roentgen Ray as an Aid in the Diagnosis of Hemophilia. Edwin L. Rypins. Am. Jour. Roentgenol. and Rad. Ther., May, 1934, **31,** 597–602.

In a review of the reproductions of the roentgenograms of various authors on hemophilic joints, and a study of three of his own cases, the author demonstrates that there are characteristic changes in the knee joints in cases in which they have been the seat of previous hemorrhage. The intercondylar fossa of the femur shows widening and deepening, with or without arthritic changes. When the elbow is involved, the head of the radius shows marked flattening and enlargement. In both joints, lipping may be present. Other conditions do not cause quite the same changes.

S. M. ATKINS, M.D.

INFLAMMATORY DISEASES

Roentgen Therapy of Pelvic Inflammatory Disease. Andreas Dapsy. Strahlentherapie, 1935, **52,** 85–96.

The author treated 40 cases of pelvic inflammatory disease with small doses of roentgen rays (160 K.V., 15 to 20 per cent H.E.D. on the skin, 30 cm. F.S.D., two or three times at weekly intervals). Six were acute cases, 11 subacute, and 23 chronic cases. The blood picture and the sedimentation velocity of the erythrocytes were carefully studied. Two of the subacute and two of the chronic cases were cured. Two of the acute, two of the subacute, and five of the chronic cases showed marked improvement. No change was seen in three acute, five subacute, and fifteen chronic cases. Abscess formation occurred in one subacute and one chronic case. Since the percentage of cure was relatively small, namely, only 10 per cent, the author recommends that roentgen therapy should be used in such cases only as have failed to show improvement with every other type of therapy.

ERNST A. POHLE, M.D., Ph.D.

THE KIDNEYS

Congenital Absence of One Kidney. Margaret Moore White. British Jour. Urol., December, 1934, **6,** 354–357.

The author reports two cases of congenital absence of one kidney.

DAVIS H. PARDOLL, M.D.

Echinococcus Cyst Attached to Kidney: Case Report. M. J. Geyman and D. M. Clark. Am. Jour. Roentgenol. and Rad. Ther., April, 1934, **31,** 541, 542.

The authors report a case of echinococcus cyst attached to the kidney, and quote statistics to the effect that 75 per cent of these cysts are in the liver, the next most common site is the lungs, and other locations are extremely rare. When the wall is not calcareous, those arising from the lower edge can be demonstrated better with inflation of the colon with air. The demonstration of those within the liver, the authors feel, should be aided by thorotrast.

S. M. ATKINS, M.D.

THE LUNGS

The Radiologic Picture of Bronchiectasis. Mario Belli. Arch. di Radiol., 1934, **10,** Pt. 1, 321–353.

Belli (from the Consorzio e dispensario provinciale antitubercolare di Milano) feels that in the diagnosis of bronchiectasis the ordinary x-ray examination is less valuable than the usual clinical examination, and is of no value when the lesion is behind the heart shadow and also even, in some cases, in which the lesion lies outside the cardiac shadow. With suitable roentgenologic technic it is possible to show, in the great majority of cases, some indirect signs of the greatest value in making a diagnosis in cases in which bronchiectasis is only suspected. In some typical cases a diagnosis may be made by the clinical and roentgenologic findings. Belli is of the opinion that bronchographic methods of examination are the most certain ones, especially in those cases in which it is important to localize the bronchiectatic area and to determine its extent for surgical reasons. He illustrates some typical roentgenologic findings in this group.

E. T. LEDDY, M.D.

THE MASTOIDS

Roentgen Examination of the Mastoid Processes. Frederick M. Law. Am. Jour. Roentgenol. and Rad. Ther., April, 1934, **31,** 482–486.

For obtaining complete roentgenologic data both with reference to the anatomy and the pathology of the mastoid process, the author recommends the routine use of the 15° angle position, the vertex-mental view, and the 23° angle postero-anterior view, all made stereoscopically, and, at times, supplementary study to be made using the Arcelin or Granger positions. The vertex-mental view is made as a matter of record to determine the appearance of the petrous bone and tip of the pyramid in case complications arise requiring subsequent consideration of the possibility of a petrositis. For demonstrating a cholesteatoma, a denser than usual exposure is necessary; the Granger projection is helpful in determining its depth. All cases with a history of chronic discharge should have the benefit of denser films in order to demonstrate a possible eroded cavity. Stereoscopic films are considered absolutely essential for a correct interpretation of early softening of the deeper cells lying between the posterior canal wall and the wall of the sinus. According to the author, "a technically perfect film never shows the condition worse than it is; it is more likely

to be just the opposite." While it is possible to demonstrate an erosion of the petrous apex roentgenographically, the interpretation of a petrositis should not be made except with careful correlation of the clinical findings, and preferably by demonstrating changes by serial studies.

J. E. HABBE, M.D.

PARKINSON'S DISEASE

Parkinson's Disease. Nandor Kiss and Bela Szirmak. Röntgenpraxis, November, 1934, **6,** 746–748.

Eight patients with Parkinson's disease were treated by the authors, six of them post-encephalitic. The two cases in older individuals were not benefited by treatments, while all six post-encephalitic cases were definitely improved for as long as six months. X-ray treatment is only a symptomatic treatment based on the influence of the rays on the sympathetic nervous system. It is, therefore, impossible to achieve complete cure, but the marked symptomatic improvement is much worth while. The treatment can be repeated best after an interval of six months. The region of the superior thoracic and inferior and median cervical ganglia is irradiated with fairly large doses of fractionated treatments.

HANS W. HEFKE, M.D.

THE PROSTATE

Sarcoma of the Prostate. Oswald S. Lowsley and Francis N. Kimball. British Jour. Urol., December, 1934, **6,** 328–348.

This analysis is based on 132 reported cases in which the diagnosis is undisputed.

Prostatic sarcoma is common to all ages: 35.59 per cent of cases occur before the age of 20. Prostatic sarcoma is most frequently associated with an infiltration of the urinary bladder, seminal vesicles, and rectum.

Regional extension occurs in 76.51 per cent of the cases, is most frequently met with in the round-cell type, and is most frequent during the first decade.

Metastases are most frequently seen in the round- and spindle-cell sarcomas, which are also the most malignant types.

Metastases occur most frequently by way of the lymphatics, the kidney being the most frequent site of metastatic implantation.

The most favorable results in treatment have been by the use of the x-ray and radium. Operative intervention should be limited to relief of obstruction and the treatment of complications.

DAVIS H. PARDOLL, M.D.

RADIATION EFFECTS

The Effect of Short and Ultra-short Electric Waves on Anorganic and Organic Compounds. E. Hasché and H. Leunig. Strahlentherapie, 1935, **52,** 179–186.

The authors studied the effect of electric waves of from 3.5 to 21 meters on blood serum, chicken protein, starch, metal colloids, phosphor, silver chromide, and other anorganic substances. No specific change of any of these could be detected, even after exposure to these waves for several hours. Changes observed in the protein of the human body were apparently due to heat.

ERNST A. POHLE, M.D., Ph.D.

RADIUM

Radon Ingestion and its Possible Health Dangers. Howard H. Barker. Am. Jour. Roentgenol. and Rad. Ther., May, 1934, **31,** 673–675.

Assuming an operator is engaged in the application of self-luminous material to clock dials for 8 hours a day, 5 days a week, and 50 weeks per year, and knowing the average radon content of workshops to-day, as has been proven by competent investigators, it can be shown mathematically that in all probability there is no hazard to the operator. The alpha-ray exposure is no more than it would be if there was permanently deposited in the system 0.00004 microgram of radium element—totally insignificant. The alpha radiation from the polonium formed from the active deposit is slight, probably 2 per cent of the alpha radiation produced by the radon. The chance of accumulation of the active deposit of slow change in the system is practically *nil.* The possibility of harmful effects from ingestion of radon as administered therapeutically, either by inhalation or injection, is very remote.

S. M. ATKINS, M.D.

Contribution to the Dosimetry of Radium Rays. P. Dumont. Strahlentherapie, 1935, **52,** 152–161.

The distribution of radiation given off by radium applicators can be determined accurately only if the radio-active substance is immovable within the carrier. A number of tests carried out by the author showed that the radio-active substance sealed in radium tubes is movable and that the distribution of the radiant energy depends on the position of the screen. It seems best, therefore, to use small applicators because the radio-active substance is much less movable than in the larger size.

ERNST A. POHLE, M.D., Ph.D.

Sterilization of Radium and Mesothorium Needles for Surgical Purposes. W. Gericke and H. Leunig. Strahlentherapie, 1935, **52,** 162–166.

The authors studied the various methods for sterilizing radium and mesothorium needles. They found that boiling water is tolerated well by radio-active needles. The radiation itself, emitted by needles filtered through 0.2–0.5 mm. Pt does not sterilize their surface. Alcohol and ether disinfection does not sterilize them in all instances. The best method for sterilizing radium needles is, therefore, boiling water.

ERNST A. POHLE, M.D., Ph.D.

RESPIRATORY TRACT

Dyspnea. J. C. Meakins. Jour. Am. Med. Assn., Nov. 10, 1934, **103,** 1442–1445.

Ordinarily in the healthy individual respiration is an unconscious function, although it can be modified at will. This review concerns itself with the unconscious or spontaneous act of respiration. The turnover from inspiration to expiration is brought about by what is commonly called the Hering-Breuer reflex, which is supposed to depend on variations in tension of the alveolar walls. The pathway for the afferent impulses is through the vagus, while the efferent impulses pass by way of the phrenic and spinal nerves. There is strong evidence to suggest that in the mid-brain (anatomically vague but physiologically fairly definite) there is an area called the respiratory center, which initiates the respiratory rhythm and controls the points of the reflex. This center is, in its turn, responsive to its own hydrogen ion concentration which is one of the most constant of the internal equilibriums. The control of respiration depends on two factors, one chemical, the other nervous.

Dyspnea can be produced by either increased acidity or decreased oxygenation of the respiratory center. But there is also a local pulmonary factor, which may be of profound significance in the genesis of dyspnea. Any condition, such as pulmonary engorgement, that decreases the distensibility of the lung will exaggerate the excitability of the Hering-Breuer reflex. In other words, any condition that increases the rigidity of the lung will tend to produce rapid and shallow breathing, with dyspnea.

Attempts to correlate the degree of dyspnea with various measurements, such as the vital capacity and the ventilation equivalent, have been shown to be thoroughly untrustworthy. It can be shown that the degree of respiratory impairment is directly proportional to the ratio of the functional residual air to total capacity of air. In obstruction, asthma, emphysema, and probably in pneumonoconiosis, the functional disturbances of respiration are chiefly inherent in the difficulties of expiration. Inspiration is accomplished by the action of a strong muscular mechanism. Expiration is ordinarily a passive act furthered by the negative intrapleural pressure, but in those conditions due to the loss of elasticity it is transformed into an active function producing a positive intrapleural pressure, which, in time, undoubtedly will be harmful to the return flow of the venous blood.

CHARLES G. SUTHERLAND, M.D.

SALIOGRAPHY

The Technic of Saliography. E. Simon. Röntgenpraxis, July, 1934, **6,** 471–480.

The author reports his experience with saliography, that is, the roentgenological examination of the salivary glands after the introduction of contrast material. The first attempts by using skiodan were not successful: 40 per cent iodipin oil is the proper substance. The papilla of Stenon's duct is slightly dilated by a probe, then a long cannula with a small olive on its end is introduced—the olive prohibits escape of the iodinized oil into the mouth. Anesthesia is not necessary. After two or three, sometimes five, c.c. of the contrast substance have been injected, the gland feels tense. A straight lateral roentgenogram of the mandibular region is made. Several cases are described, illustrating the value of this type of examination in diseases of the parotid gland. Occasionally the sublingual gland may have to be examined in a similar way; such a case is also reported.

HANS W. HEFKE, M.D.

SINUSES (DIAGNOSIS)

Anomalies in the Position of the Planum Sphenoidale and Their Diagnostic Significance. Ernst G. Mayer. Röntgenpraxis, July, 1934, **6,** 427–431.

The sphenoidal plane is that portion of the upper bony wall of the sphenoidal sinus which lies just anterior to the anterior clinoid process. Its level is usually just a little lower than the upper edges of the small wings of the sphenoid bone. A very low planum sphenoidale may be caused by pressure of a tumor above or by a very marked increase of the intracranial pressure. An elevation of this plane has been observed by several authors. It is caused by meningiomas (in combination with an osteoma-like thickening), mucoceles of the sphenoid sinuses, and osteomas. Several cases are described.

HANS W. HEFKE, M.D.

THE SKIN

The Regional Variations in the Skin Reaction. J. Borak. Strahlentherapie, 1935, **52,** 74–84.

The author observed that in certain patients there is a difference in the skin reaction in different parts of the body following the application of identical doses. A study of this problem leads him to the conclusion that the parts of the skin which are close to the bone react less than other skin. This difference in susceptibility is shown by the epidermis as well as by the blood vessels. He offers a hypothesis in an attempt to explain this difference in reaction.

ERNST A. POHLE, M.D., Ph.D.

Reactions in Skin and Mucous Membrane Following Protracted Fractional Roentgen Therapy. R. Sarasin. Strahlentherapie, 1935, **52,** 61–73.

The author has studied the reactions developing in patients following treatment with the Coutard technic. He emphasizes that this type of therapy has to be strictly individualized. Skin reaction and mucous membrane reactions do not run parallel. It is possible to determine the approximate date on which the reaction in the mucous membrane will appear; its intensity and duration must be adjusted to the requirements of each patient. There is a definite relation between the radiosensitivity of the mucous membrane and that of

tumors originating in that membrane. The radiosensitivity of the skin is independent thereof. It is possible to reduce the reactions in both skin and mucous membrane by short wave therapy and infra-red exposures. A number of photographs show various types of reactions observed by the author.

ERNST A. POHLE, M.D., Ph.D.

THE STOMACH

The Treatment of Extensive Malignant Lesions of the Stomach. Waltman Walters. Jour. Am. Med. Assn., Nov. 3, 1934, **103,** 1345–1348.

Carcinoma of the stomach can be detected by a competent roentgenologist in 95 per cent of cases, and roentgenographic examination of the stomach of patients 40 years of age or more who have indeterminate dyspepsia is the most important procedure in the examination, never to be omitted in any suspicious case. Every gastric lesion should be regarded as malignant, or potentially so, until proved otherwise. The decision to treat a patient with an ulcerating gastric lesion by medical measures carries a great responsibility, for, if the lesion is malignant, by the time it is found to respond unsatisfactorily to medical treatment sufficient time may have elapsed for it to have become completely irremovable. The recognition of the fact that the small gastric ulcer is frequently malignant, as likewise may be other small lesions of the stomach such as polypi, will frequently enable an attack to be made on such lesions while they are in stages most favorable to cure.

CHARLES G. SUTHERLAND, M.D.

THE TONSILS

Roentgen Therapy of Tonsillitis. E. D. Dubowyi and E. I. Olschanowskyi. Röntgenpraxis, July, 1934, **6,** 441–447.

After reviewing the literature pertaining to roentgen therapy of tonsillitis the authors report their results with this treatment in 163 patients. During two years they irradiated 450 patients with tonsillitis, but did not use all of them for statistical purposes because sufficient time had not elapsed since their treatments. The clinical selection and the grouping of the patients was apparently done with great care and the criteria for cure or improvement were strict. In chronic tonsillitis, 62 per cent were cured, 33 per cent improved, and only 4 per cent not influenced; in hypertrophy of the tonsils, 66 per cent were cured, 28 per cent improved, and 6 per cent not influenced; in hypertrophy of the entire lymphatic ring, 69 per cent were cured, the remaining number improved. Recurrent attacks of tonsillitis were seen only twice after roentgen therapy, even if the size of the tonsils was not changed. The technic was: 210 kilovolts; a filter of 1 mm. Cu and 2 mm. Al; a skin-focus distance of 25 cm.; from 20 to 30 per cent of an erythema dose through a field measuring 5 × 6 cm. or 6 × 8 cm. applied in both infra-mandibular areas. Of the patients, 27 per cent received only one series; 57 per cent two; 14 per cent three, and 2 per cent four series. The authors do not believe that such treatment can be in any way harmful, not even in children.

HANS W. HEFKE, M.D.

TUBERCULOSIS, PULMONARY

The Specificity of Pulmonary Consolidation in Tuberculous Patients (Epituberculosis): Resolution of Experimental Tuberculous Pneumonia. Henry Stuart Willis. Am. Jour. Roentgenol. and Rad. Ther., June, 1934, **31,** 721–734.

Primary consolidation which occurs with moderate frequency in tuberculous individuals, especially children, is due to tuberculosis rather than atelectasis, edema, pneumococcus pneumonia, or non-specific pneumonia. Some have called this "epituberculosis." These cases offer several points that make a diagnosis of tuberculosis almost mandatory, namely, the long duration, lack of stormy symptoms, positive tuberculin reaction, positive sputum (in many cases), histologic appearance, and the reappearance of the condition in children after injection of tuberculin. The positive sputum especially may be present during the height of the consolidation.

Experimental work on this condition was performed on rabbits, the larger portion of the experiment being concerned with the introduction of human tubercle bacilli into previously tuberculosis-infected (sensitive) animals. The results definitely bore out the premise of the paper both roentgenologically and pathologically.

S. M. ATKINS, M.D.

TUMORS (DIAGNOSIS)

Multiple Fibromas of the Tunica Vaginalis. G. Gordon-Taylor. British Jour. Urol., December, 1934, **6,** 320–327.

The author describes a case of multiple fibromas of the tunica vaginalis. A review of the literature and several illustrations accompany the article.

DAVIS H. PARDOLL, M.D.

TUMORS (THERAPY)

The Hemangio-endothelioma and its Susceptibility to Irradiation. Rudolf Baumann-Schenker. Strahlentherapie, 1935, **52,** 11–19.

The author reports five cases of hemangio-endothelioma, which seems to occur more frequently in goiter areas. These tumors are radiosensitive, sometimes as much as a lymphoblastoma. Even bone metastases may respond well. The total doses applied in these five cases varied from 1,200 to 6,900 r. Two patients died, two were still well eight months and two and a half years, respectively, after the treatment. One case was treated by a combination of surgery and irradiation and was still well six months later.

ERNST A. POHLE, M.D., Ph.D.

The Problem of the Treatment of Malignant Tumors. Paolo Buisson. Arch. di Radiol., 1934, **10,** Pt. 1, 354–363.

Buisson is of the opinion that ordinary surgical and radiologic methods of treating tumors hold out little promise because they are based on the false theory that malignant tumors, at least at their outset, are local lesions. He prefers to regard malignant tumors as manifestations of a generalized disease, and thinks that they should be treated as such. In this regard he feels that pan-irradiation, telepan-irradiation, or supertelepan-irradiation, based on the technics of Palmieri and of Heublein, promise much improvement in the results that may be obtained.

E. T. LEDDY, M.D.

The Round-cell Sarcoma: Experience at the X-ray Laboratory of the University of Zurich, 1919–1934. Rudolf Baumann-Schenker. Strahlentherapie, 1934, **51**, 201–236.

Sixty cases of round-cell sarcoma subdivided in three groups, lymphosarcoma, reticulum-cell sarcoma, and round-cell sarcoma proper, are analyzed by the author. He describes the histologic and clinical character in detail. Roentgen therapy seems to be the most efficient method of treatment. In tumors of the nose and pharynx, 30 per cent of the cases remained free from symptoms for 3 years, 1 year, and 8 months, respectively. In all other types without generalized metastases, 30 per cent remained free from symptoms. In patients with metastases the result was only a palliative one. Six cases of reticulum-cell sarcoma, located, with one exception, in the nasopharynx, responded well to protracted fractional treatment; two are alive and well four and two and one-half years, respectively, after the treatment; one case is still under treatment. The experiences in the round-cell sarcoma group were similar to that in the lymphosarcoma group.

The article is accompanied by a number of very elaborate tables, giving detailed information concerning the patients observed in each group of tumors. The paper is recommended for study in the original.

ERNST A. POHLE, M.D., Ph.D.

Tumors of the Testis. Arthur U. Desjardins, Virgil S. Counseller, and Cesare Gianturco. Am. Jour. Surg., January, 1935, **27**, 71–79.

Tumors of the testis are not so rare as they have been held to be. Between 1920 and 1929, 155 patients with testicular tumors have been seen at the Mayo Clinic. These are grouped and analyzed as to the age of incidence by decades, and such analysis shows that the greatest number of orchidic neoplasms develop between the third and the sixth decades of life. In all but two cases, the tumor was unilateral. The relation of testicular tumor to undescended testis and to the influence of trauma could not be ascertained.

The results of treatment are considered from the standpoint of orchidectomy alone, roentgen therapy alone, and combined orchidectomy and roentgen therapy. Tabulation of the cases in these three groups gives the impression that the results obtained by surgery, combined with or followed by roentgen-ray treatment, are superior. This may be misleading because none of the patients in this preferred group has presented evidence of tumor for more than one year, and all were apparently free from metastasis. The patients treated by simple orchidectomy also constituted a preferred group. In the group of cases treated with roentgen rays only, the 16 patients who had died had had an average survival period of 11.4 months, a period distinctly longer than corresponding cases in the two other groups.

For various reasons, absolute conclusions cannot be drawn from this review. The impression is that patients receiving combined treatment derive more benefit than patients treated by surgical methods only, or by radiotherapy only, but in order to determine the relative value of each method by itself in comparable cases a more thorough test should be made.

On the whole, roentgen-ray treatment alone seems perferable for embryonal carcinoma, while for the mixed, or teratoid, tumors surgical removal combined with thorough post-operative irradiation seems indicated.

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THE WRIST

A Radiologic Study of Luxation of the Semilunar Bone. Edmondo Ingber. Arch. di Radiol., 1934, **10**, Pt. 1, 302–320.

Ingber discusses traumatic dislocation of the semilunar bone, of which he illustrates several cases. He emphasizes the value of the technic of Schneck (which he has modified slightly) for the demonstration of this lesion. He next illustrates the various types of dislocation of the semilunar and emphasizes the importance of a well-carried-out x-ray examination in diagnosing this uncommon traumatic lesion.

This paper supplements that of Bignami on fracture of the semilunar, and of Agati on the malacia syndrome of the semilunar, from the Institute of Medical Radiology and Physical Therapy of the Royal University of Pavia.

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